Recap on Flux Return Study

David Kapukchyan

Cold QCD Topical Group Meeting

September 6, 2016

Purpose/Goals of Study

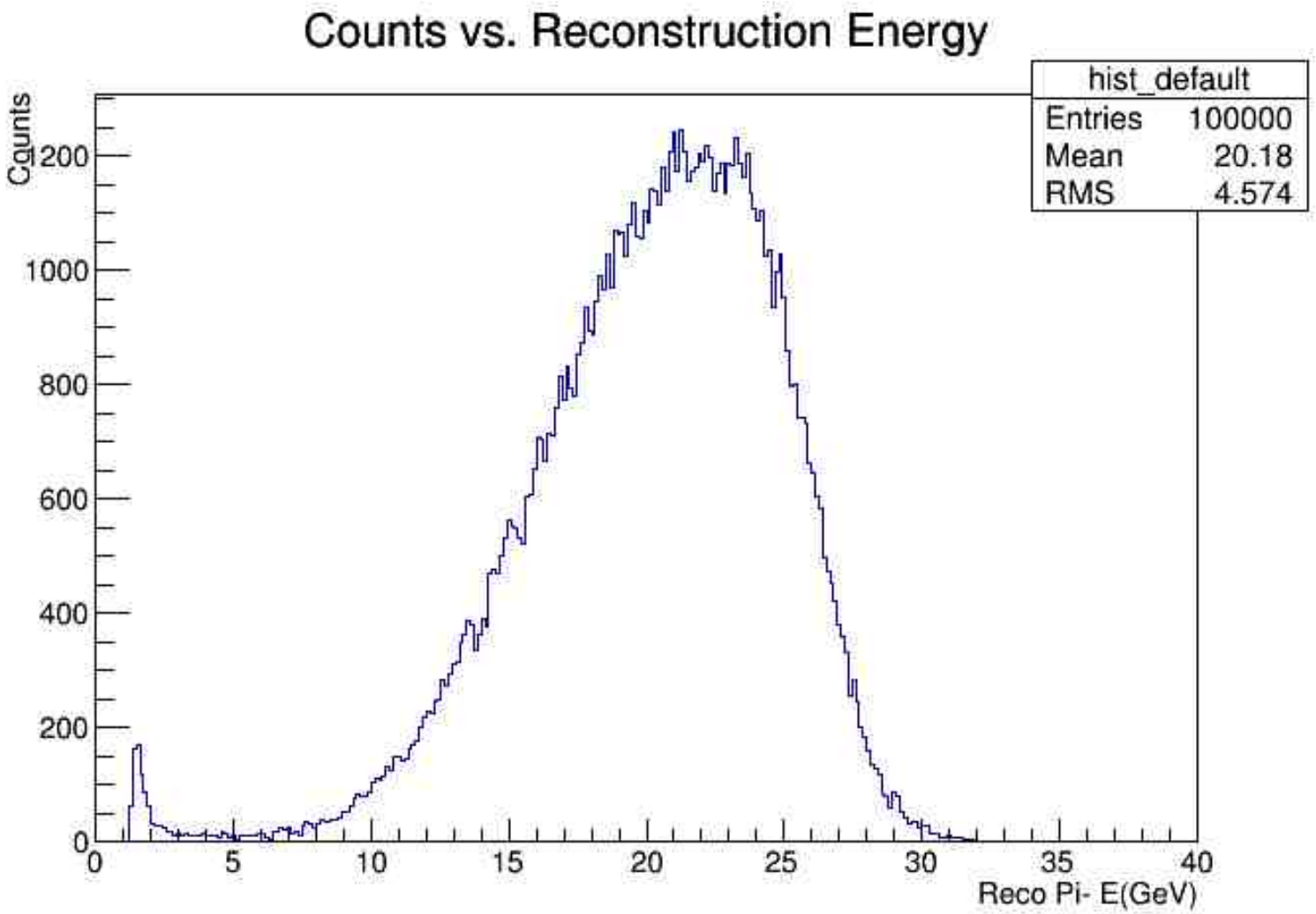
- To see how different thicknesses of the Flux Return (i.e. Plug Door) will affect the energy resolution of the Forward Calorimeters.
  - Flux Return is used as a means of returning the magnetic field of the BABAR magnet
- Run simulations using different plug door thicknesses and look at reconstructed energy vs. counts.
  - Do some fitting to this data to characterize the energy distribution and obtain some kind of mean and standard deviation.
- Run same simulations using different energies/pseudorapidities for those thicknesses.

Work so Far

- Ran simulations with charged pions (π^-)going through various thicknesses of the plug door with fixed pseudorapidity(2.0) and fixed energy (30 GeV).
- Also ran simulations with various energies and fixed plug door thickness(10.2 cm) and same fixed psuedorapidity.
- The counts were plotted as a function of the reconstructed energy from both the EMCAL and HCAL and Gaussian fits were done to this data.
- Using these fits the tail was characterized by integrating the histograms above from 0 to μ_{gauss}-2*σ_{gauss} and divided by the total number of entries.
  - This quantity was called R

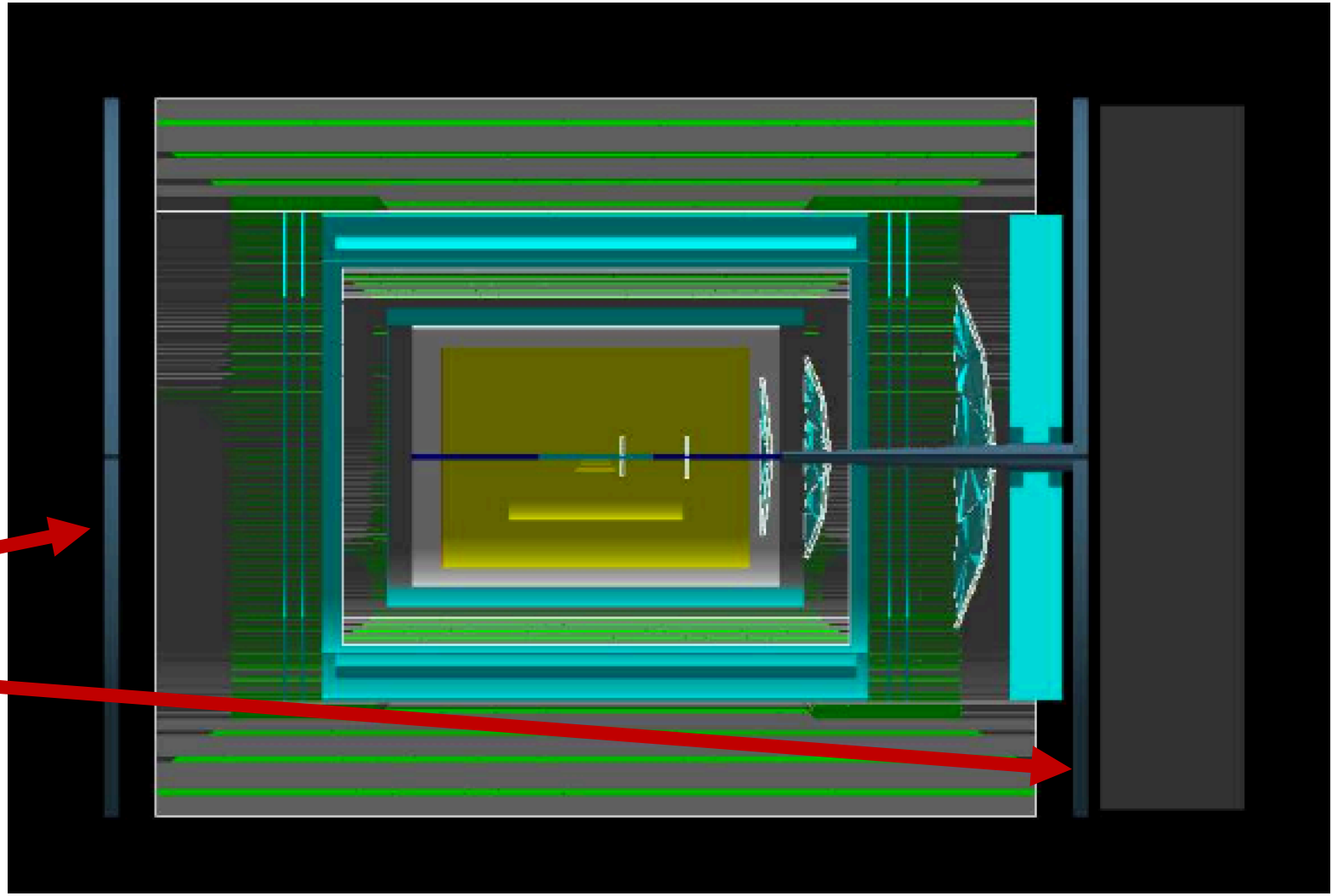
The Histograms showing Counts vs. Energy

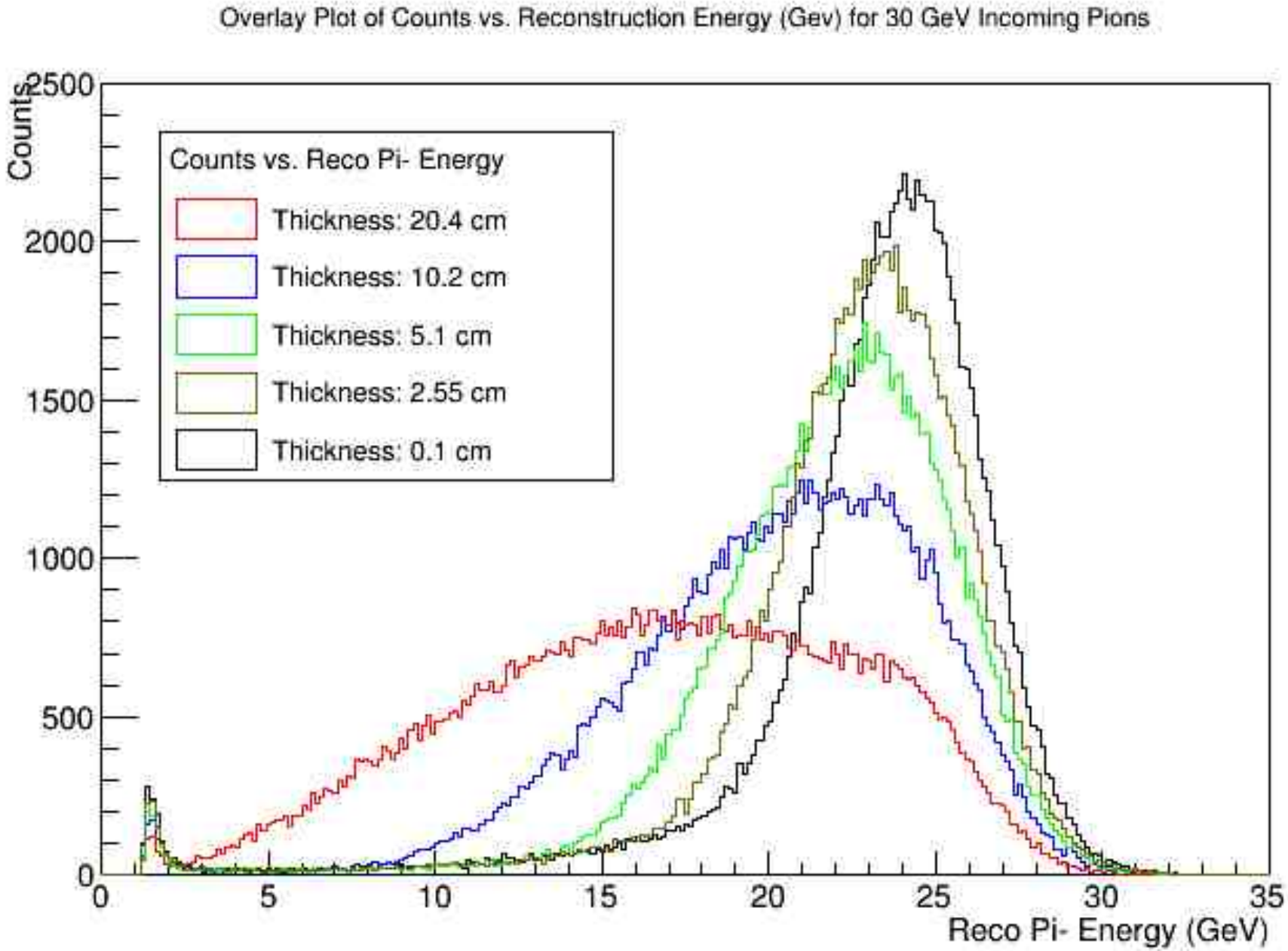
- Plot on the right is for 10.2 cm (default)
- The histograms for the other thicknesses can be found in the backup slides and are as follows
  - 20.4 cm (double)
  - 5.1 cm (half)
  - 2.55 cm (quarter)
  - 0.1 cm (millimeter)
  - 100 cm
  - 1000 cm
- Some were done as sanity checks to see how reconstruction handles extreme values



View of the detector for the histogram above

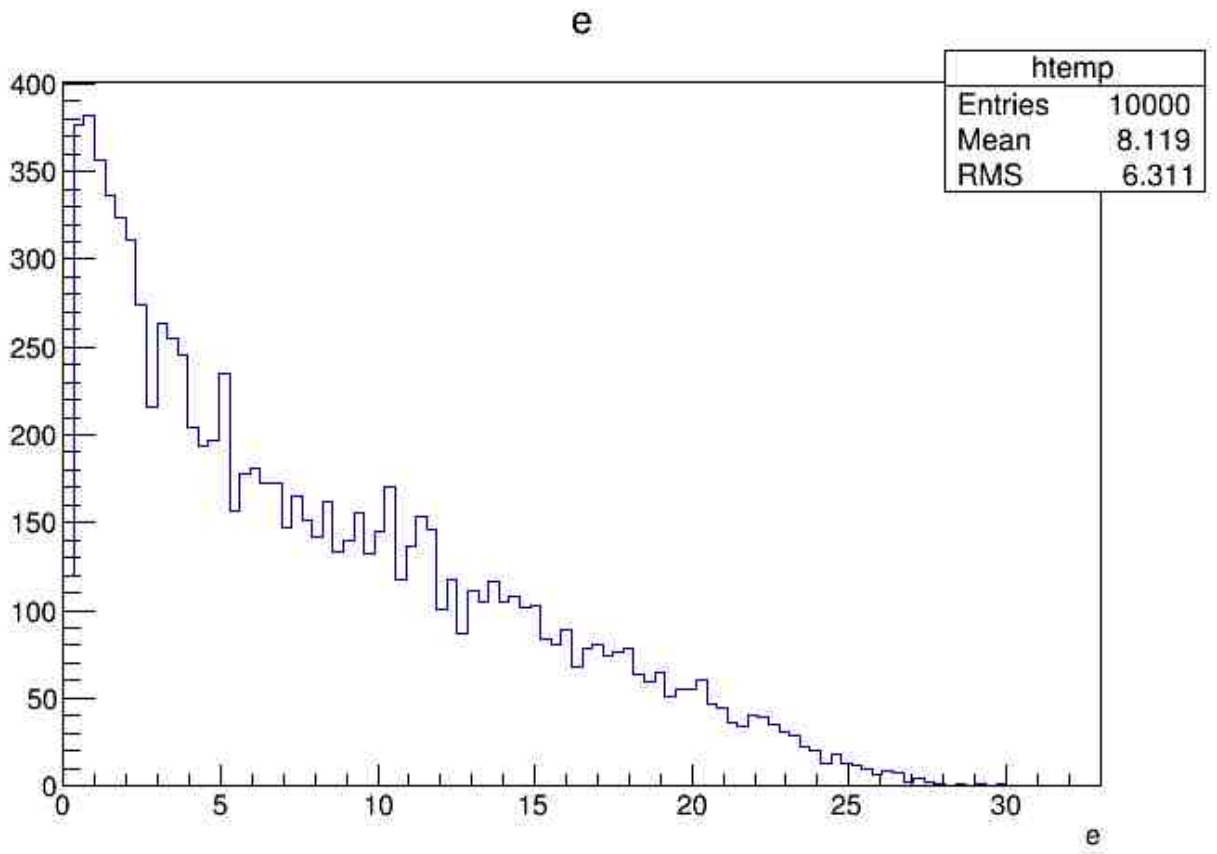
- The figure on the right is what the detector geometry looks like for the histogram above
- The other thickness can be found in the backup slides




Overlay Plot of Counts vs. Reconstruction Energy (Gev) for 30 GeV Incoming Pions
Counts
2500
2000
1500
1000
500
0
Counts vs. Reco Pi- Energy
Thickness: 20.4 cm
Thickness: 10.2 cm
Thickness: 5.1 cm
Thickness: 2.55 cm
Thickness: 0.1 cm
0
5
10
15
20
25
30
35
Reco Pi- Energy (GeV)

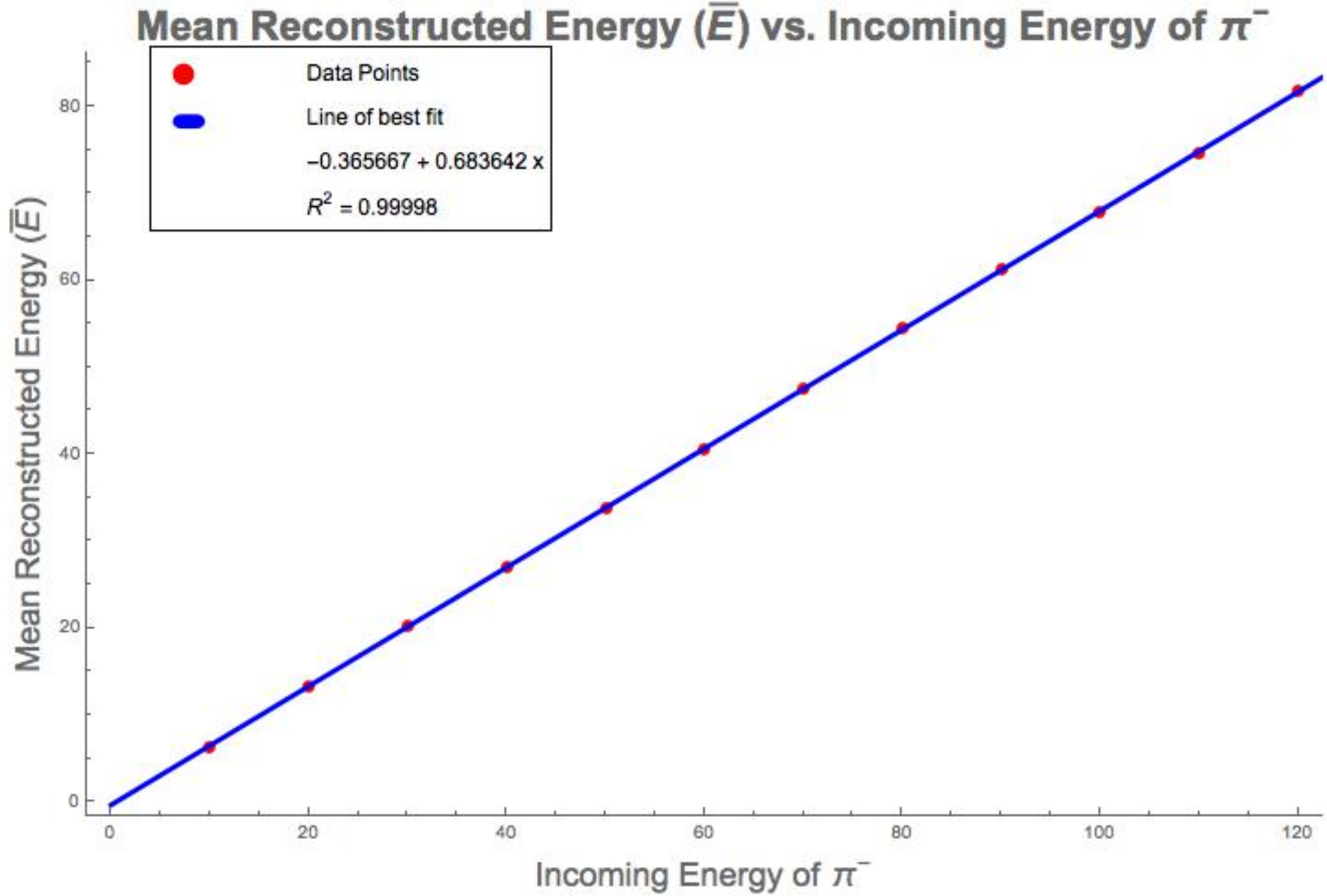
The 100 cm histogram

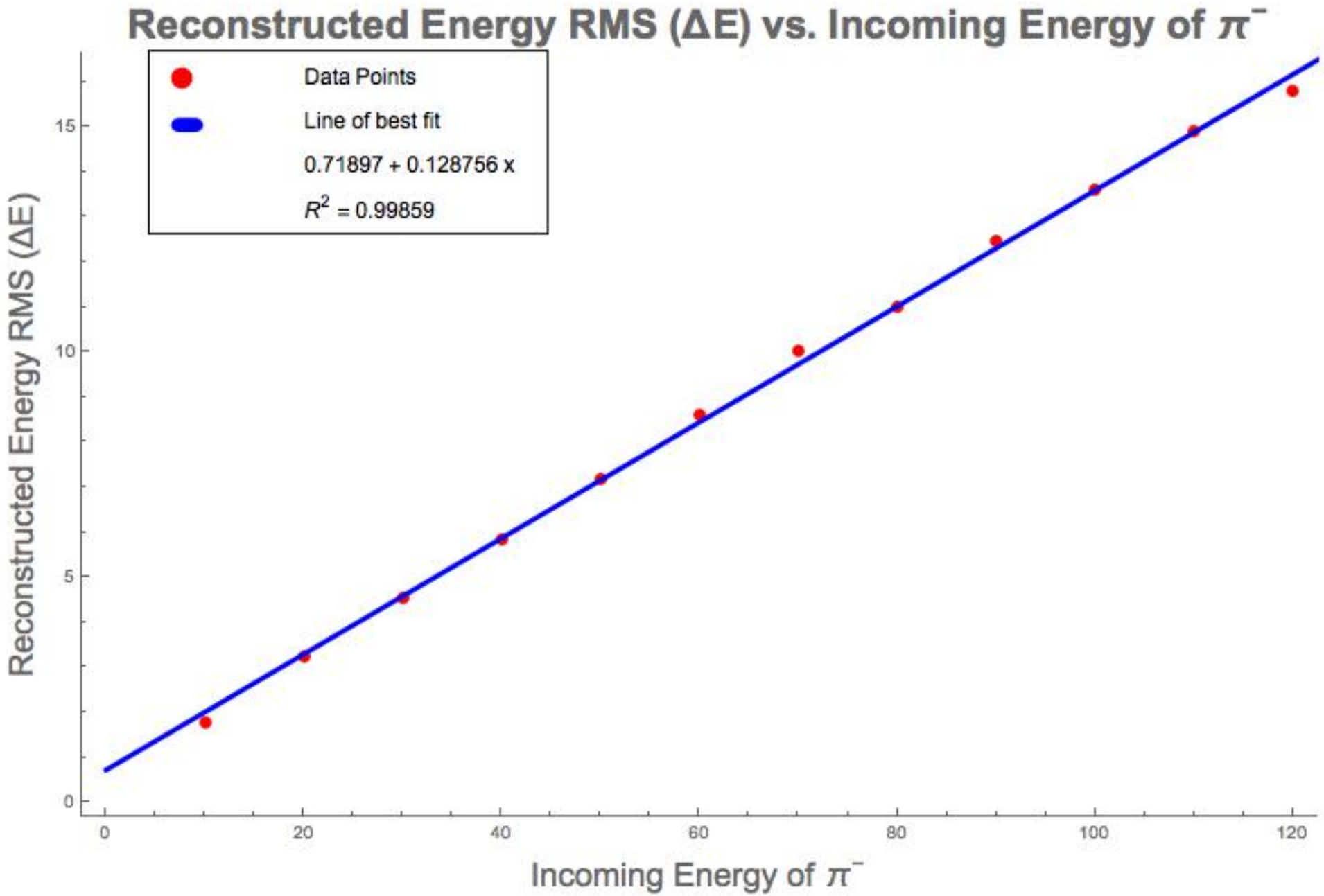
- One such extreme. You can see how the energy is being suppressed despite it overlapping with the other volumes.
- 1000 cm shown in backup is empty meaning it is too large to handle

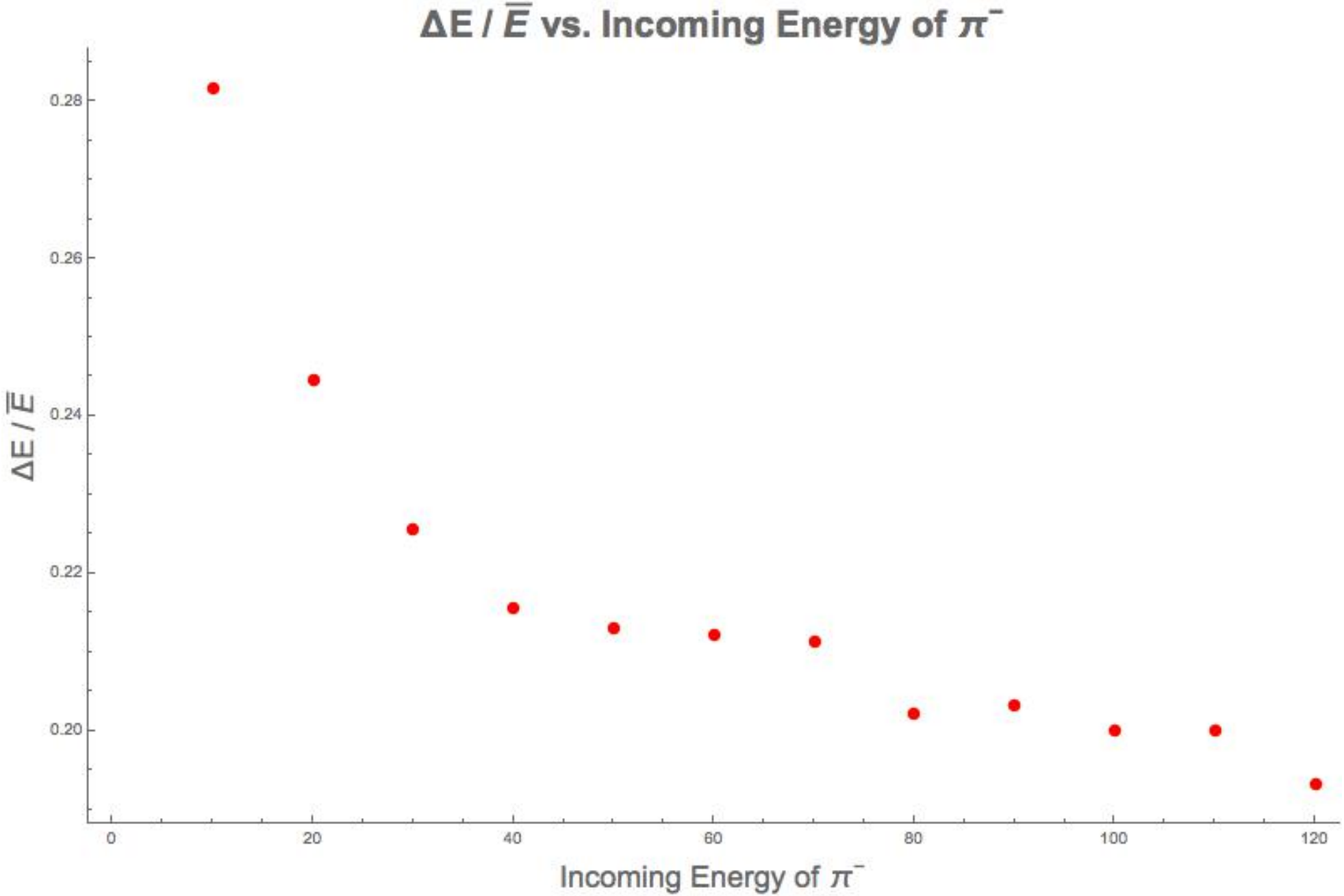


Simulations with different Energies

- Ran simulations with π^- at energies 10-120 GeV in 10 GeV steps keeping the plug door dimension its default value (10.2 cm).
- Read off the Mean ($\bar{E}$) and RMS (ΔE) values from histograms above
- Plotted $\bar{E}$, ΔE, $\Delta E/\bar{E}$ as a function of the incoming π^- energy
- Did linear fits to those plots that looked linear
- This includes all of the plots except $\Delta E/\bar{E}$
- The histograms for the various energies can also be found in the backup


Mean Reconstructed Energy ($\overline{E}$) vs. Incoming Energy of π^-
Data Points
Line of best fit
−0.365667 + 0.683642 x
R^2 = 0.99998
Mean Reconstructed Energy ($\overline{E}$)
Incoming Energy of π^-
0
20
40
60
80
100
120


Reconstructed Energy RMS (ΔE) vs. Incoming Energy of π⁻
Data Points
Line of best fit
0.71897 + 0.128756 x
R² = 0.99859
Reconstructed Energy RMS (ΔE)
Incoming Energy of π⁻
0
5
10
15
0
20
40
60
80
100
120


ΔE / $\bar{E}$ vs. Incoming Energy of π^-
ΔE / $\bar{E}$
0.28
0.26
0.24
0.22
0.20
0
20
40
60
80
100
120
Incoming Energy of π^-

Goals

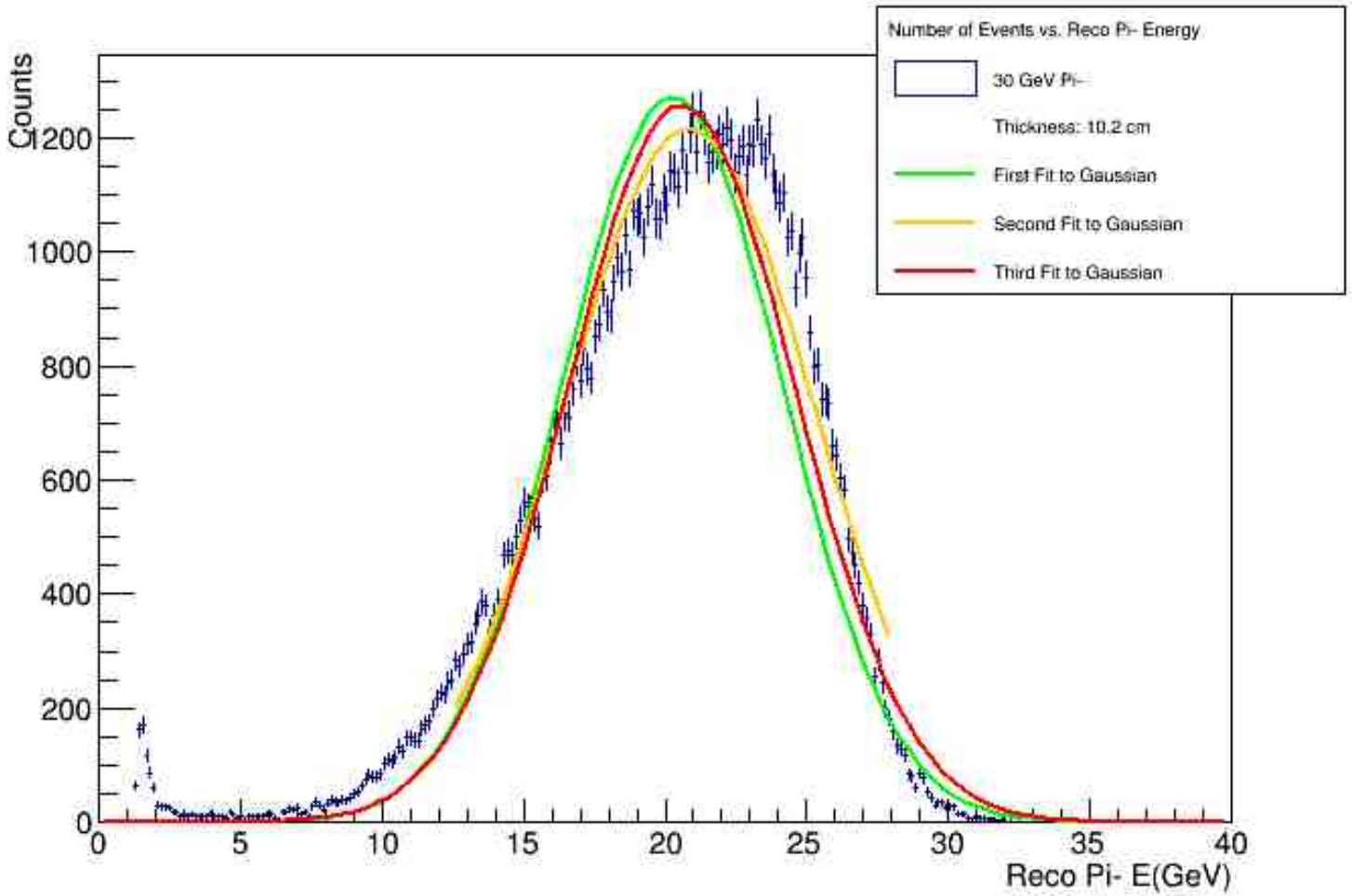
- The plots above show that things are behaving as expected
- The mean energy is increasing and the resolution is decreasing (i.e. getting wider) in a linear fashion
- Even $\Delta E/\bar{E}$ vs. Incoming π^- Energy seems to following known trend
- Since the values of $\Delta E, \bar{E}$ were read off the histograms, a better value to use may be from a fit.
- Also, to understand and characterize the tail of the histograms fitting may be needed
- So onward to fitting!

Fitting the Histograms

- Gaussian fits were performed on the histograms for the various thicknesses in the following way:
  - First fit was done to the whole range of the histogram
  - Second fit was done to $\mu_{fit} \pm 2\sigma_{fit}$
  - Third fit was to $\mu_{fit} \pm 2\sigma_{fit}$ of the second fit
- Next, the histogram was integrated from 0 to $\mu_{fit} - 2\sigma_{fit}$ of the third fit and divided by the total number of entries.
  - This quantity will be called R.
- R was plotted as a function of the flux return thickness.

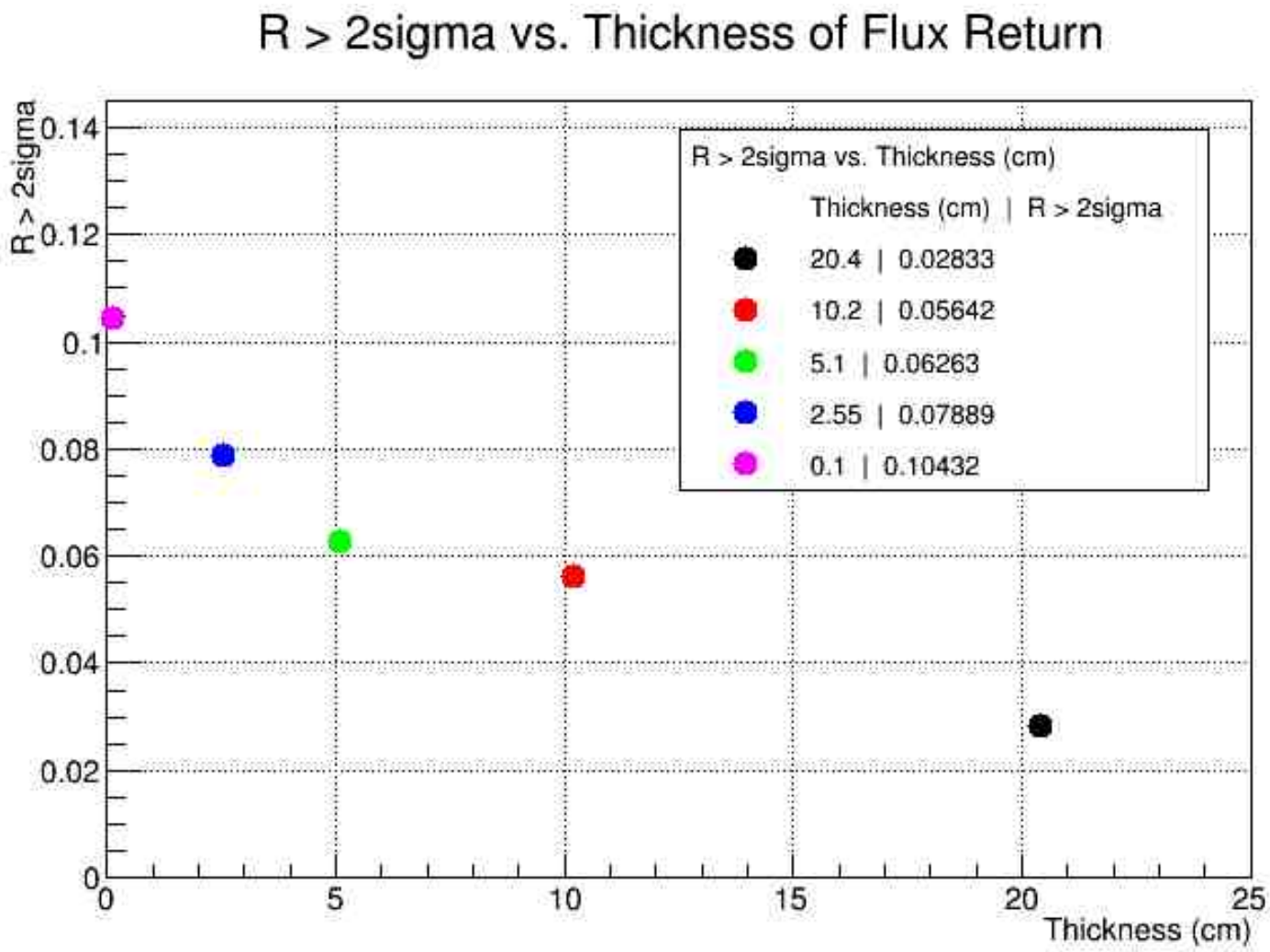
Sample of the Fits

- The plot on the right is for the default plug door length of 10.2 cm
- See Backup Slides for the other thickness values



R vs. Thickness

- The plot on the right shows R as a function of the thickness of the plug door
- It should increase as the thickness gets larger but instead It is decreasing as the thickness gets larger.
- The reason for this may be that the tail is being obscured by the Gaussian and as the thickness increases the tail disappears and the distribution becomes more Gaussian



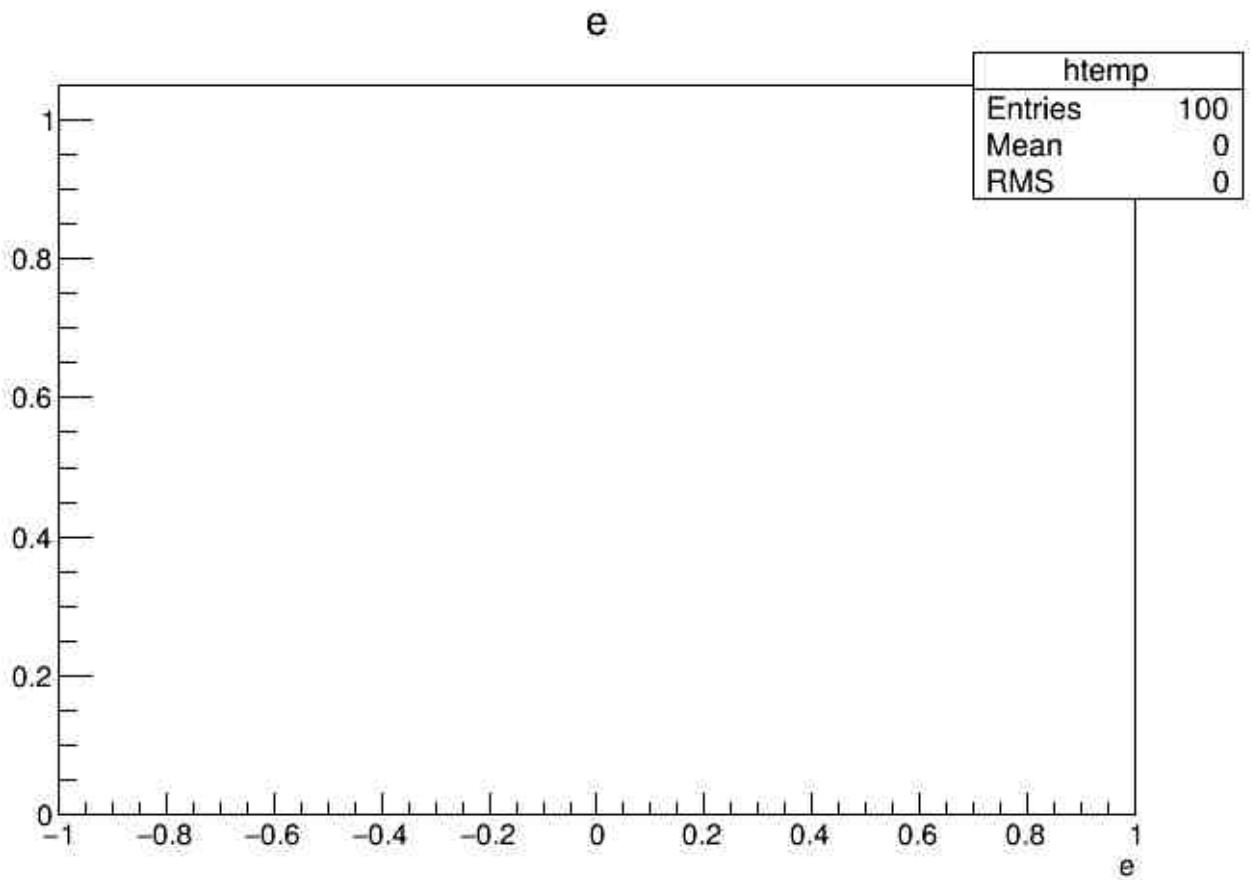
Conclusions/Work to be Done

- The different thicknesses are reducing the charged hadron energy and at the same time the energy resolution is also decreasing as expected
- The fitted histograms seem to overlap the tail and obscure the R value
- Working on a way to get “better” fits
- Once that is done then do a similar analysis at different energies using the same varying plug door thicknesses
- Also need to make plots of σ_{fit} and σ_{fit}/μ_{fit} vs. Thickness
- Thank you to all those who helped in this study

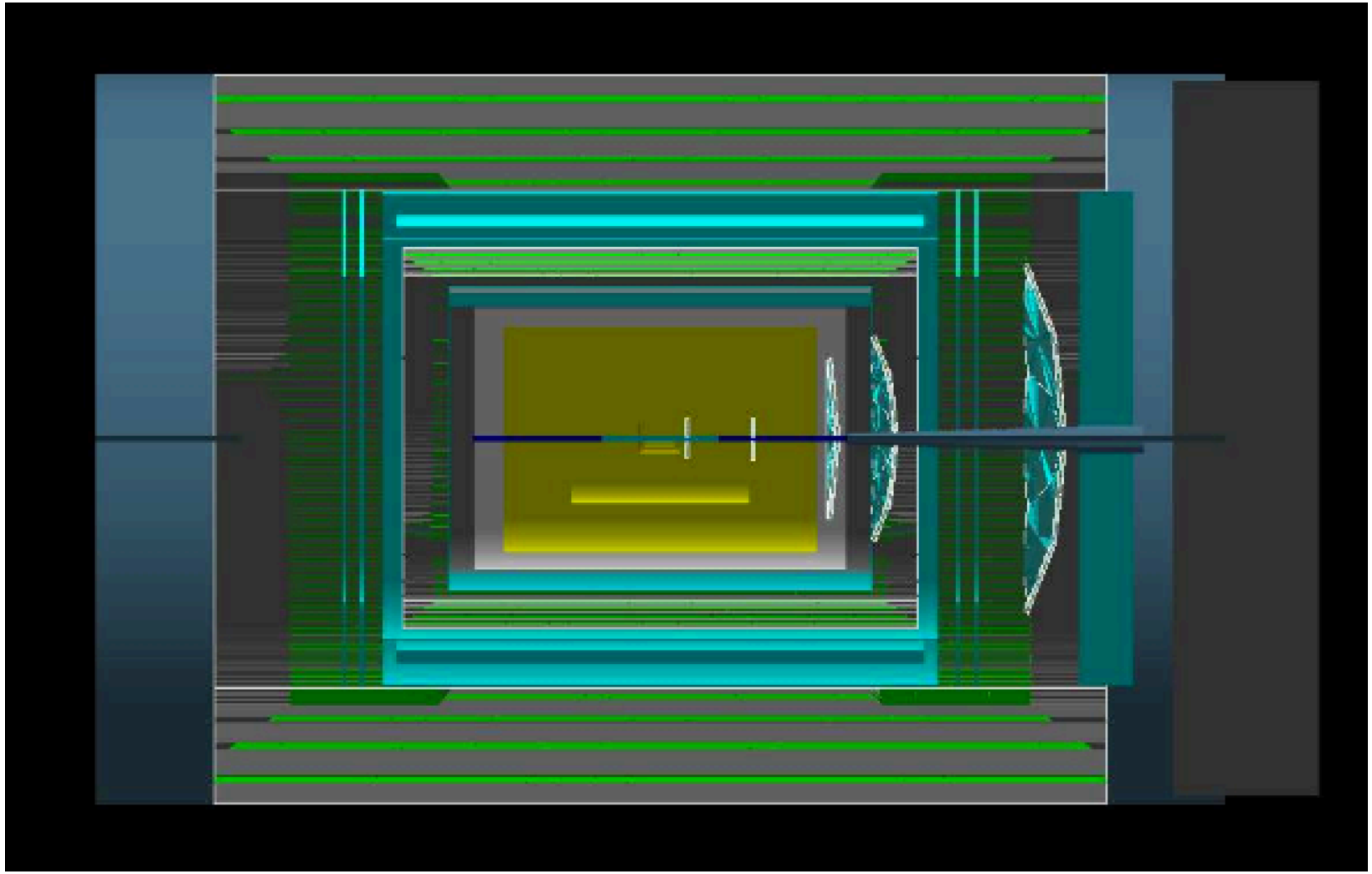
Backup Slides

Different Thickness Histograms

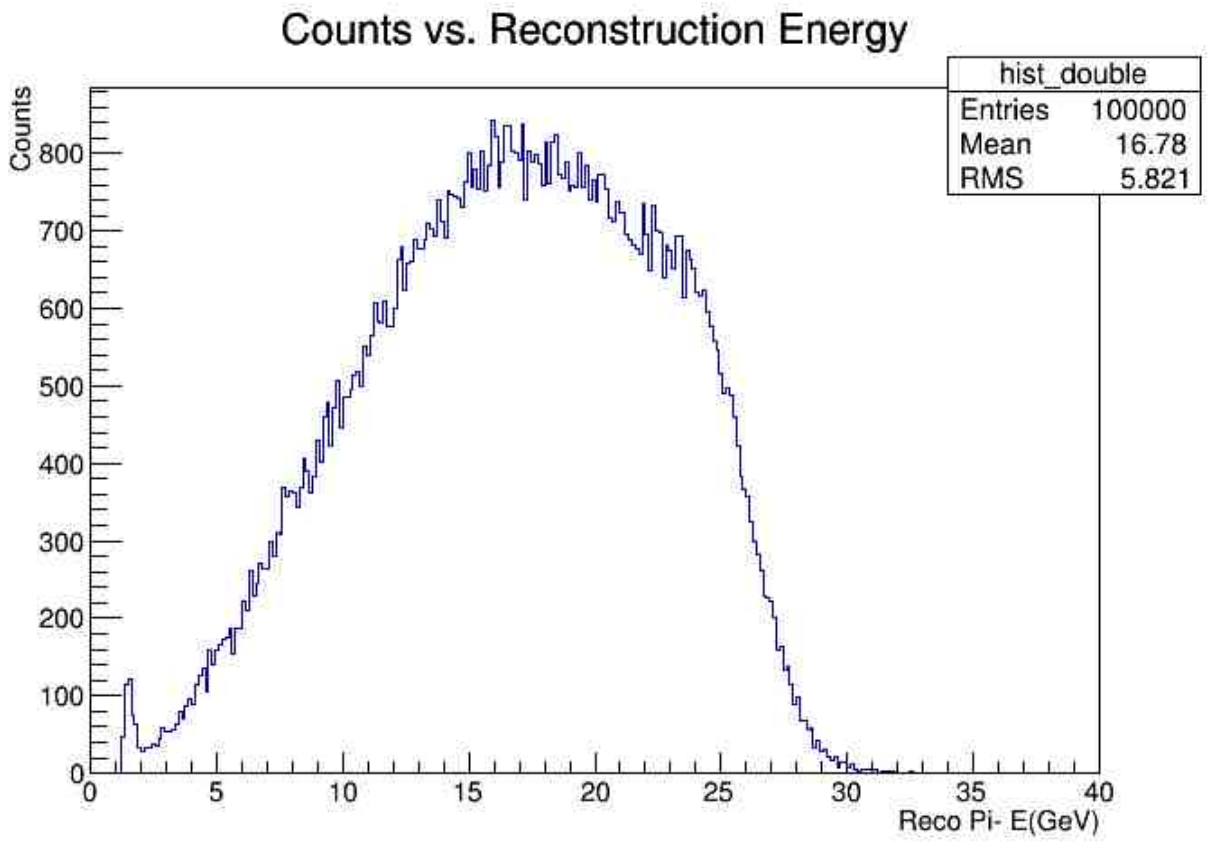
1000 cm

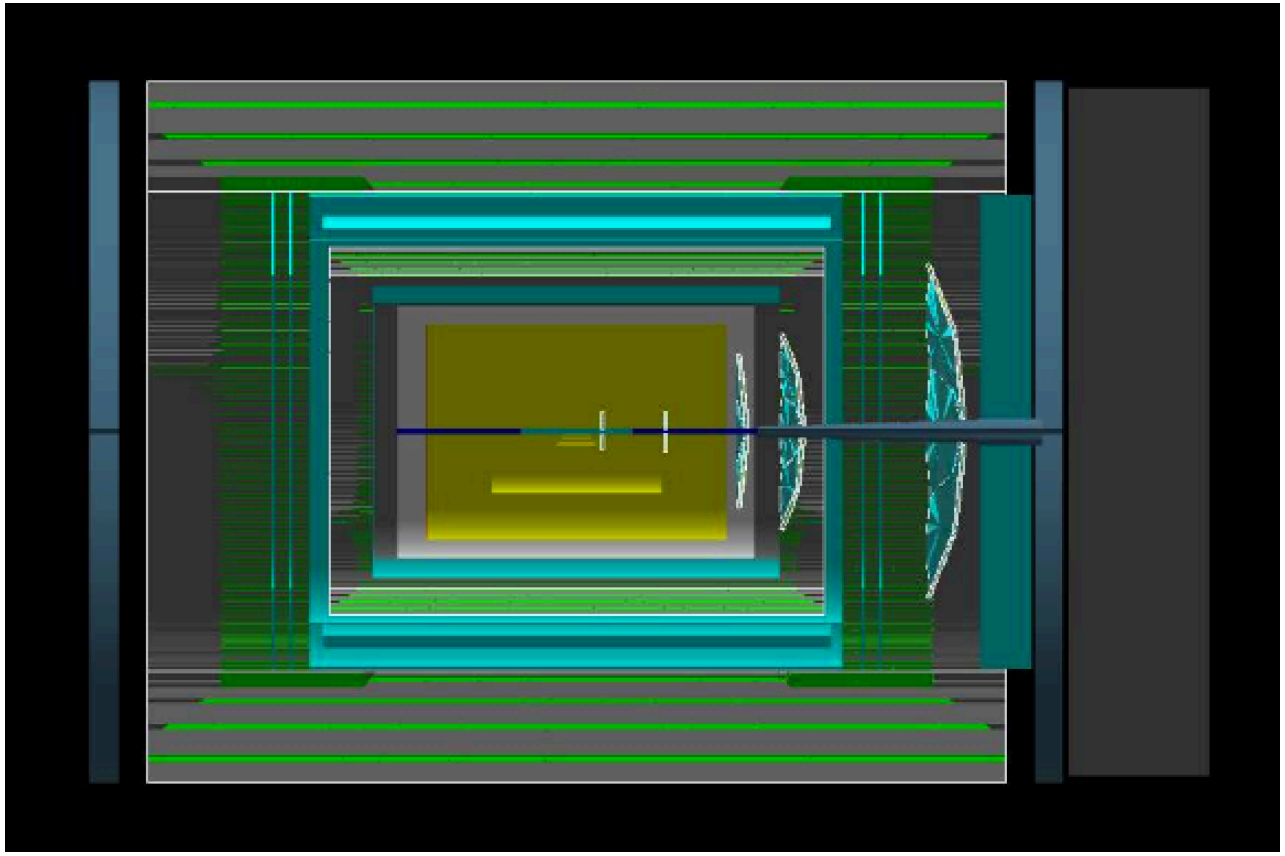

e
htemp
Entries 100
Mean 0
RMS 0
1
0.8
0.6
0.4
0.2
0
−1
−0.8
−0.6
−0.4
−0.2
0
0.2
0.4
0.6
0.8
1
e

100 cm Geometry

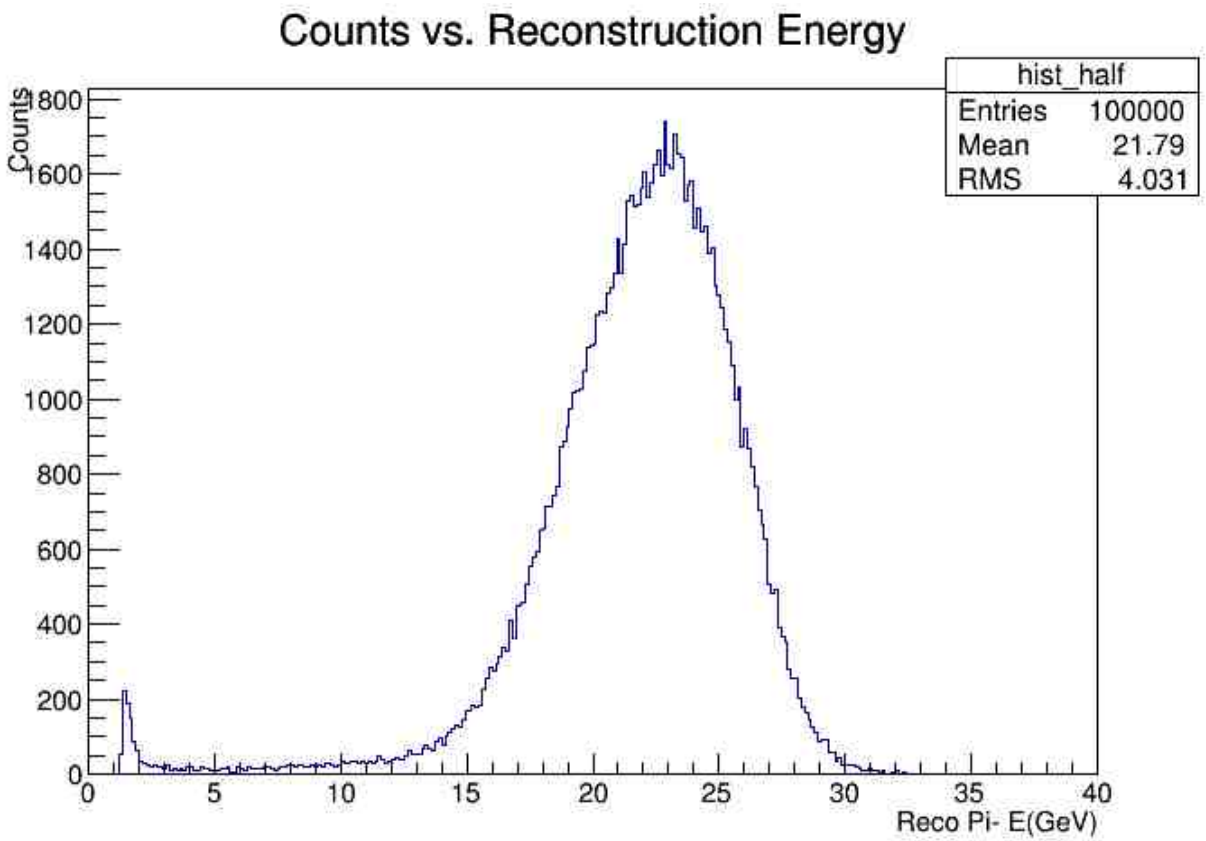


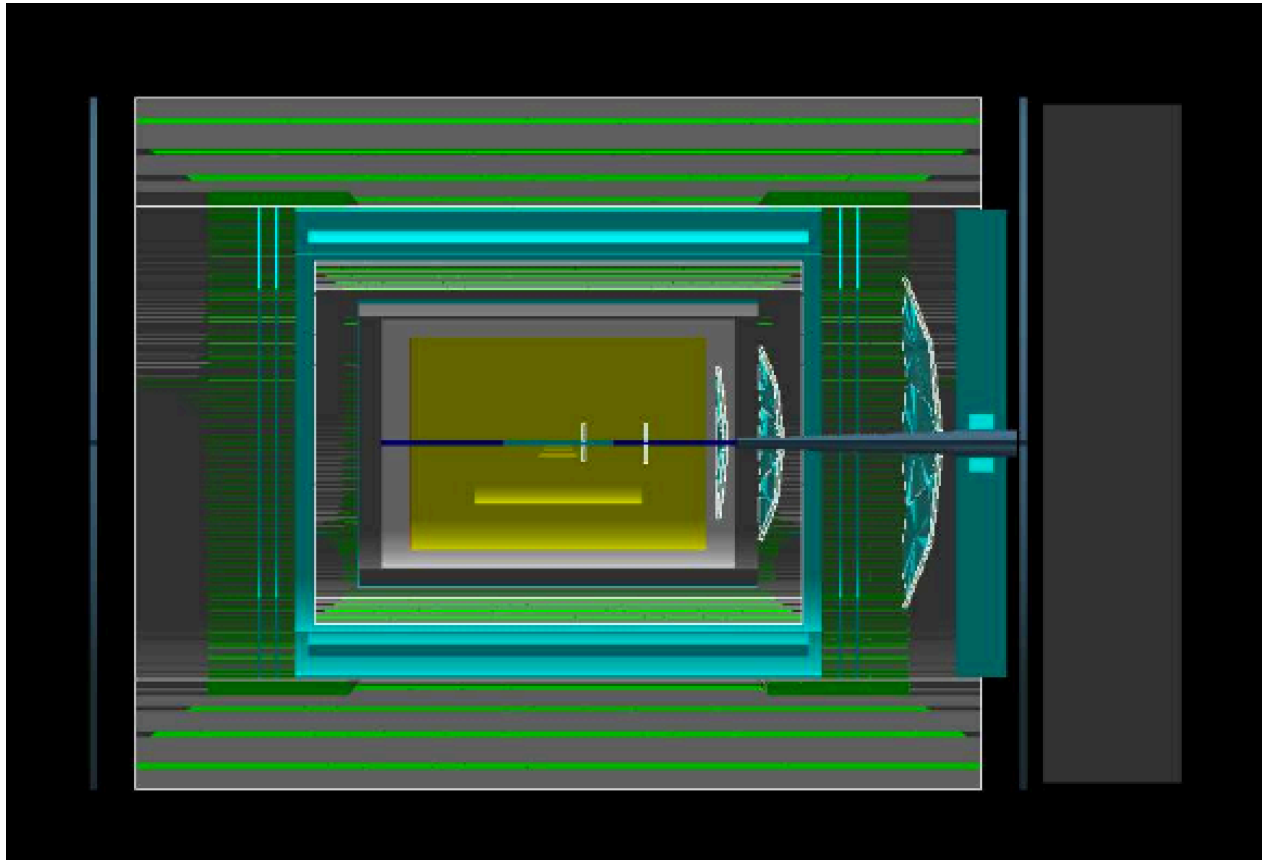
20.4 cm (Double) Plots



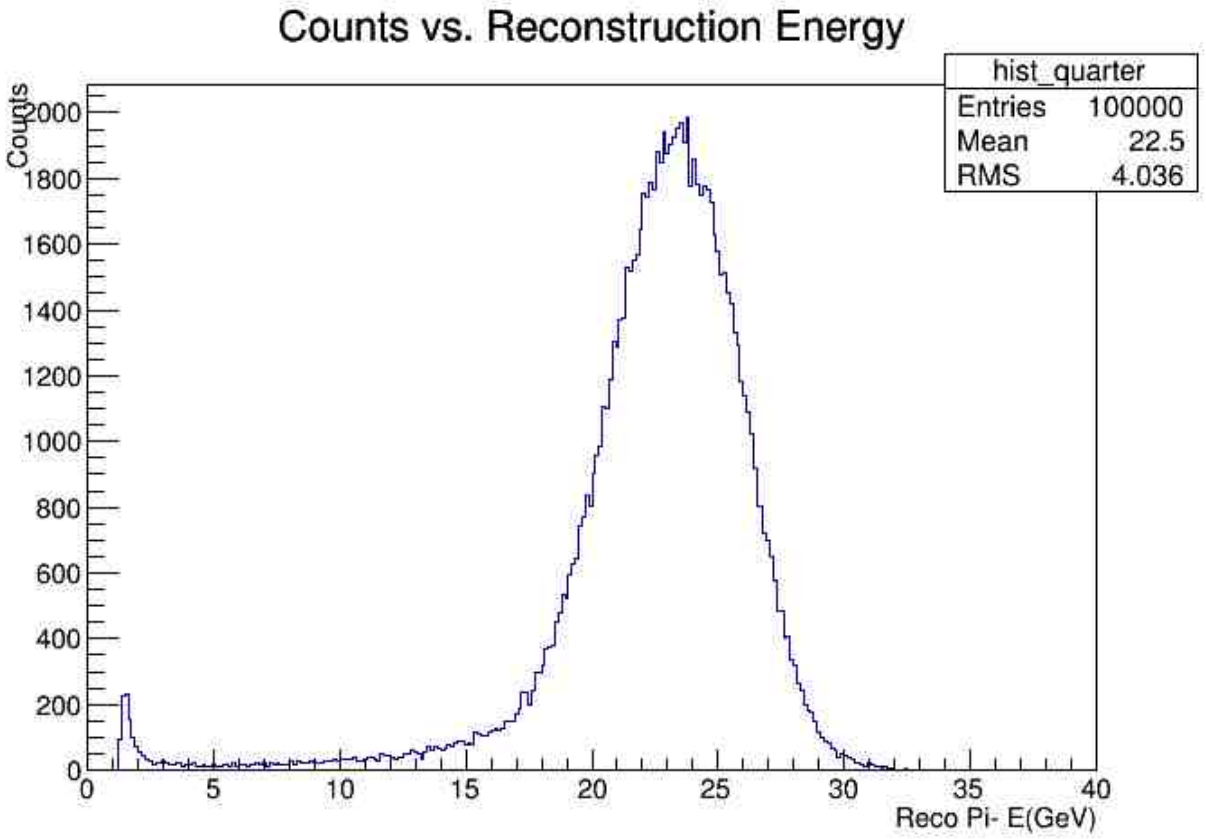


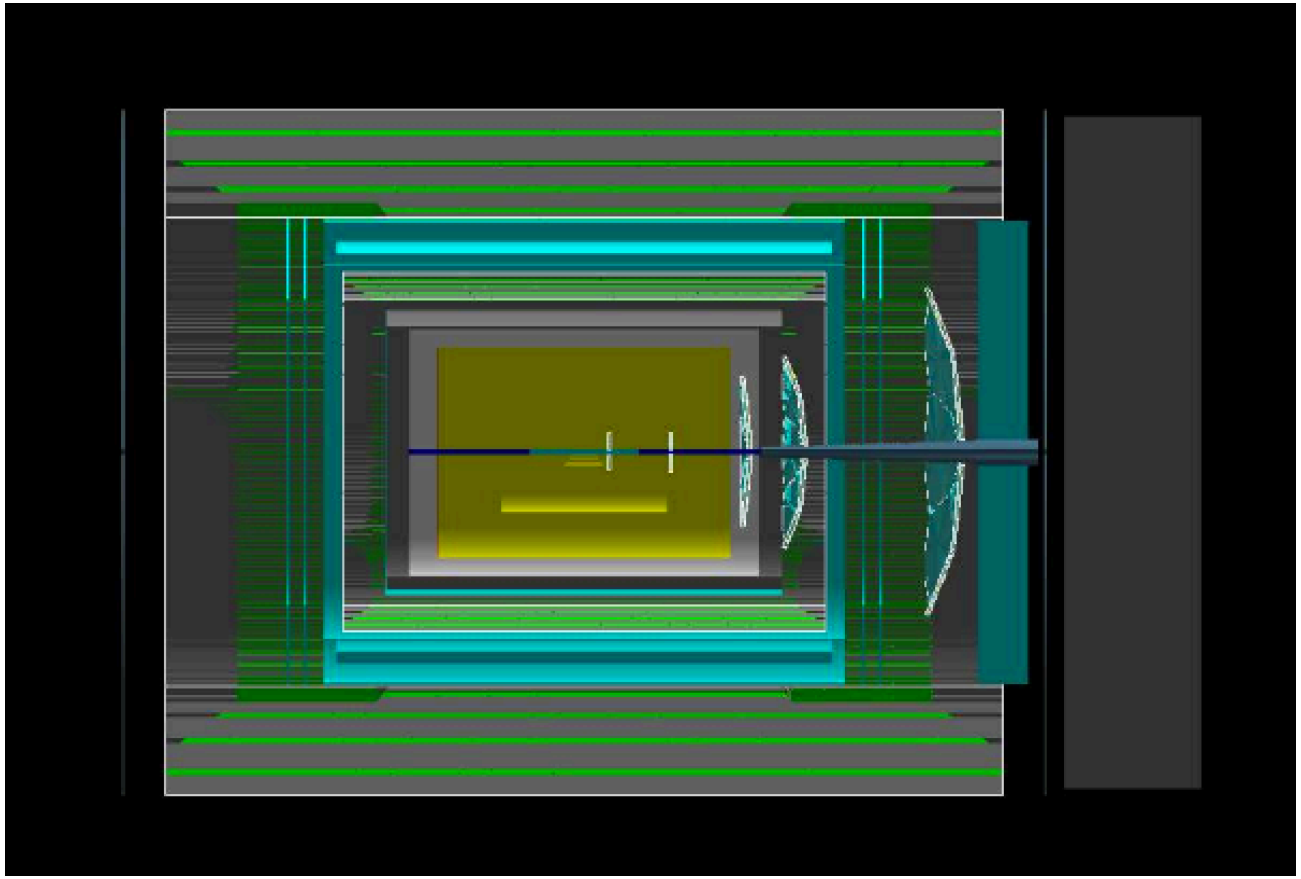
5.1 cm (Half) Plots



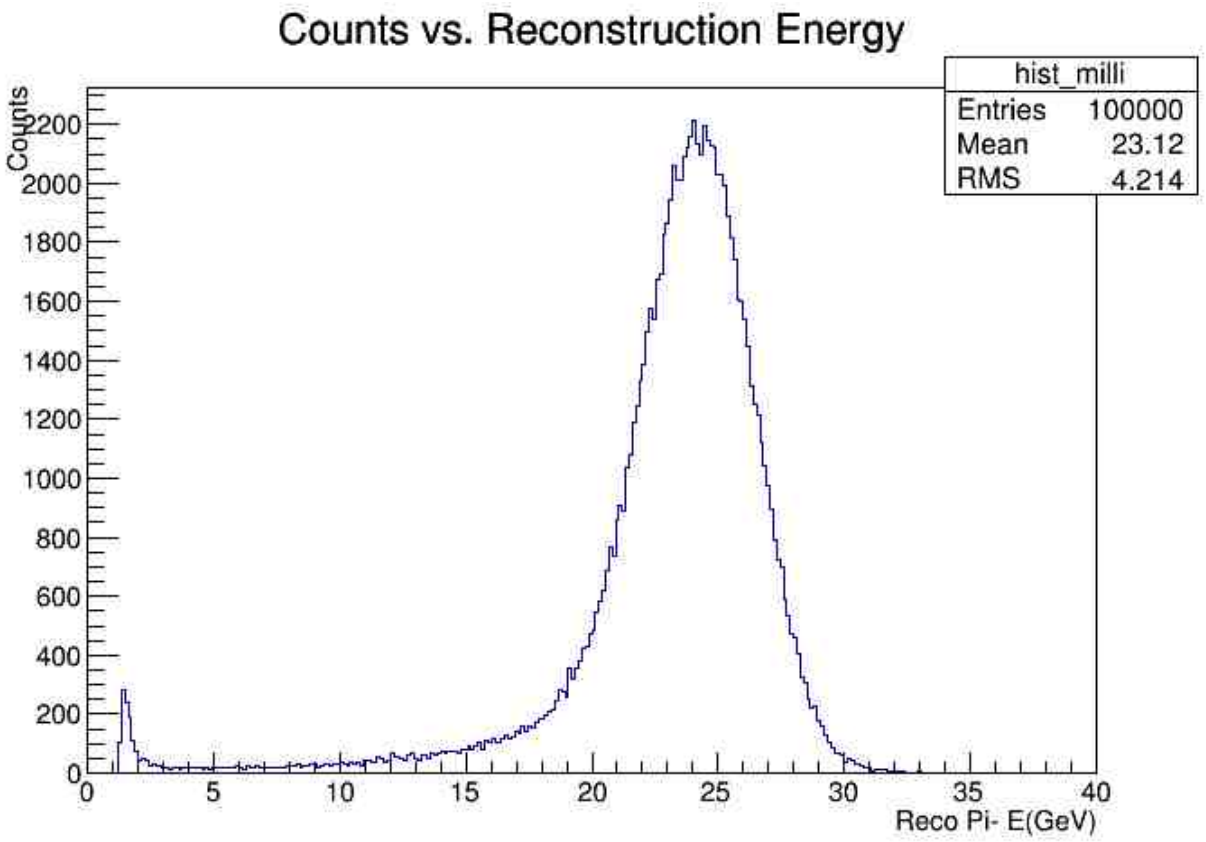


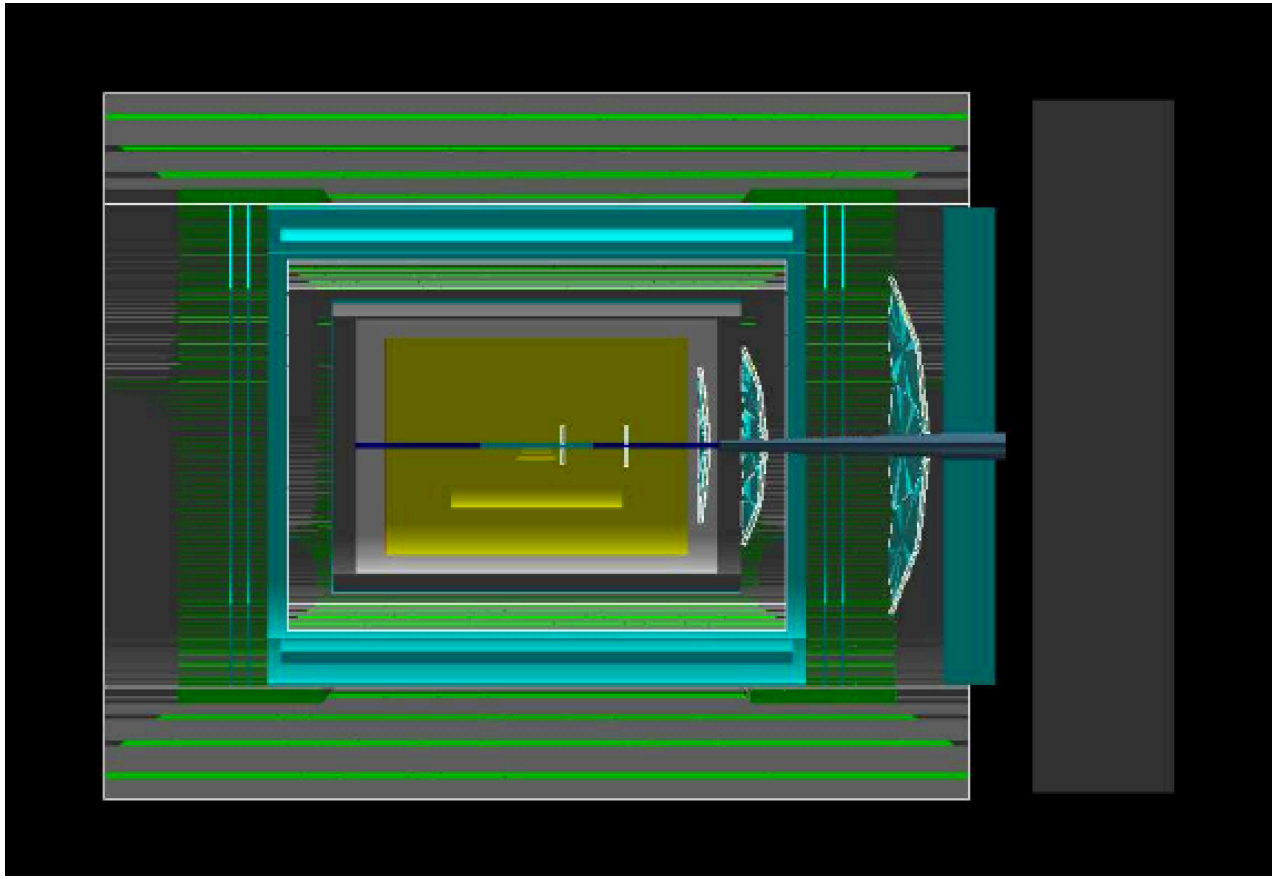
2.55 cm (Quarter) Plots





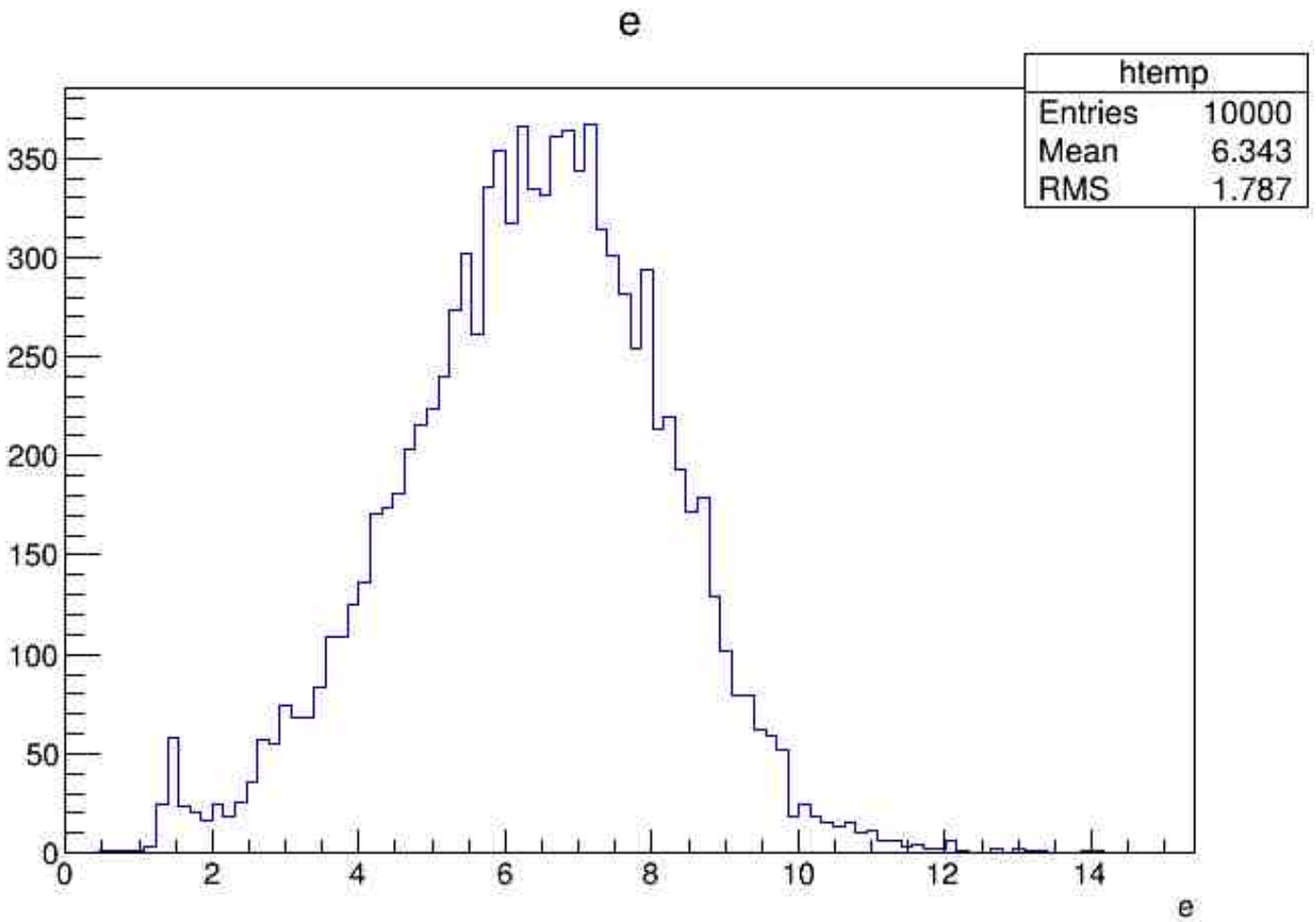
0.1 cm (Millimeter) Plots



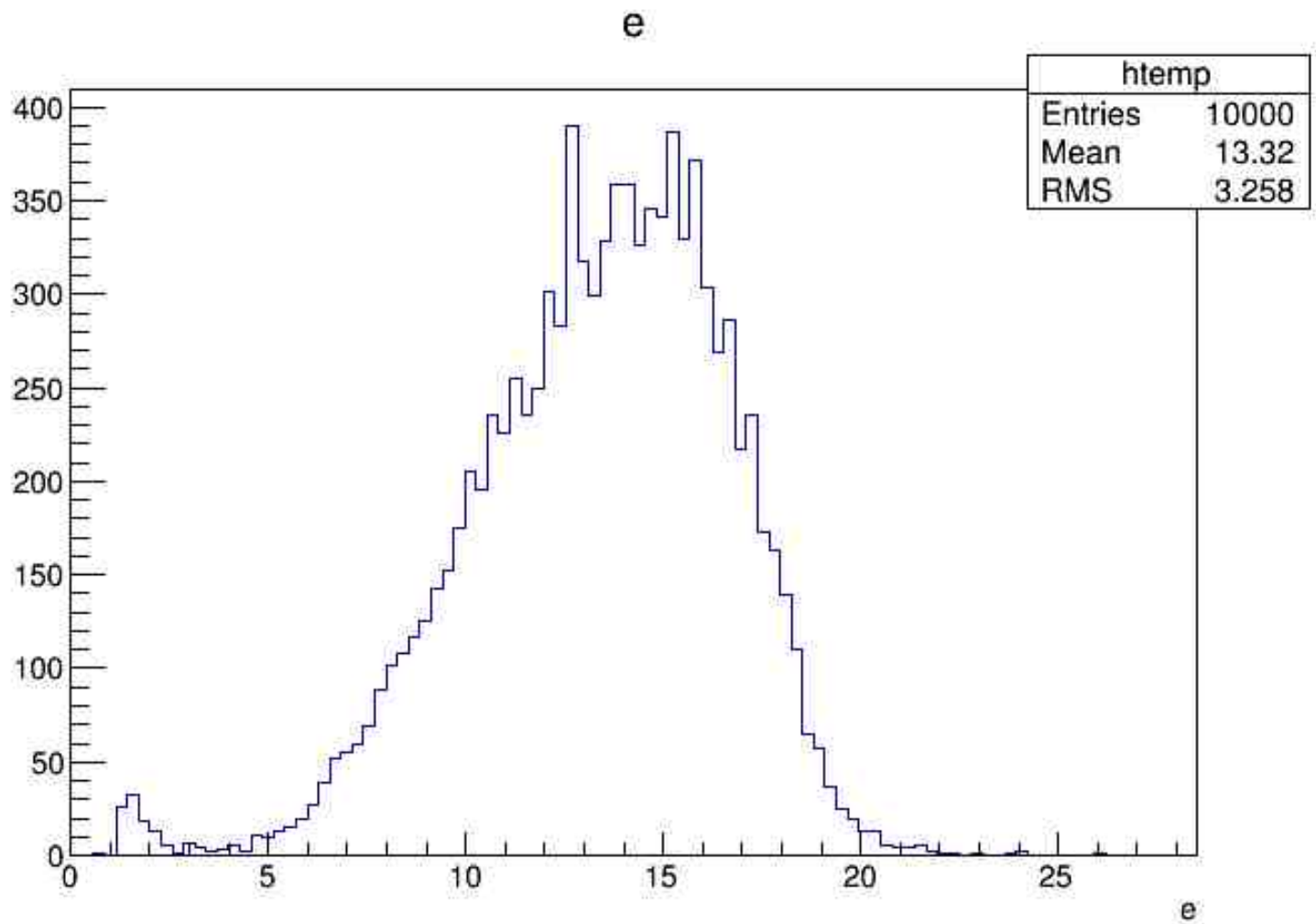


Different Energy Histograms

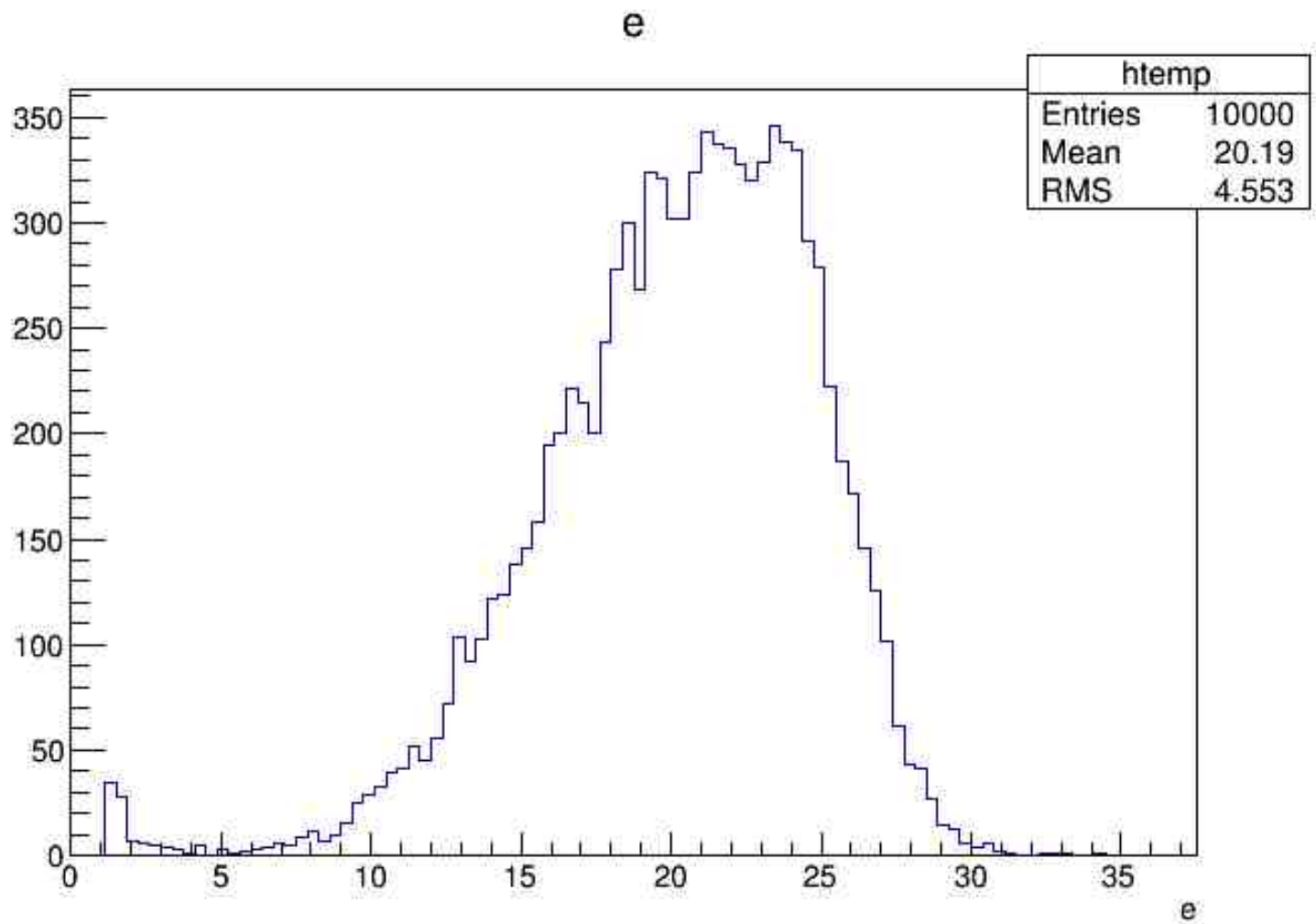
10 GeV


e
htemp
Entries 10000
Mean 6.343
RMS 1.787
350
300
250
200
150
100
50
0
0
2
4
6
8
10
12
14
e

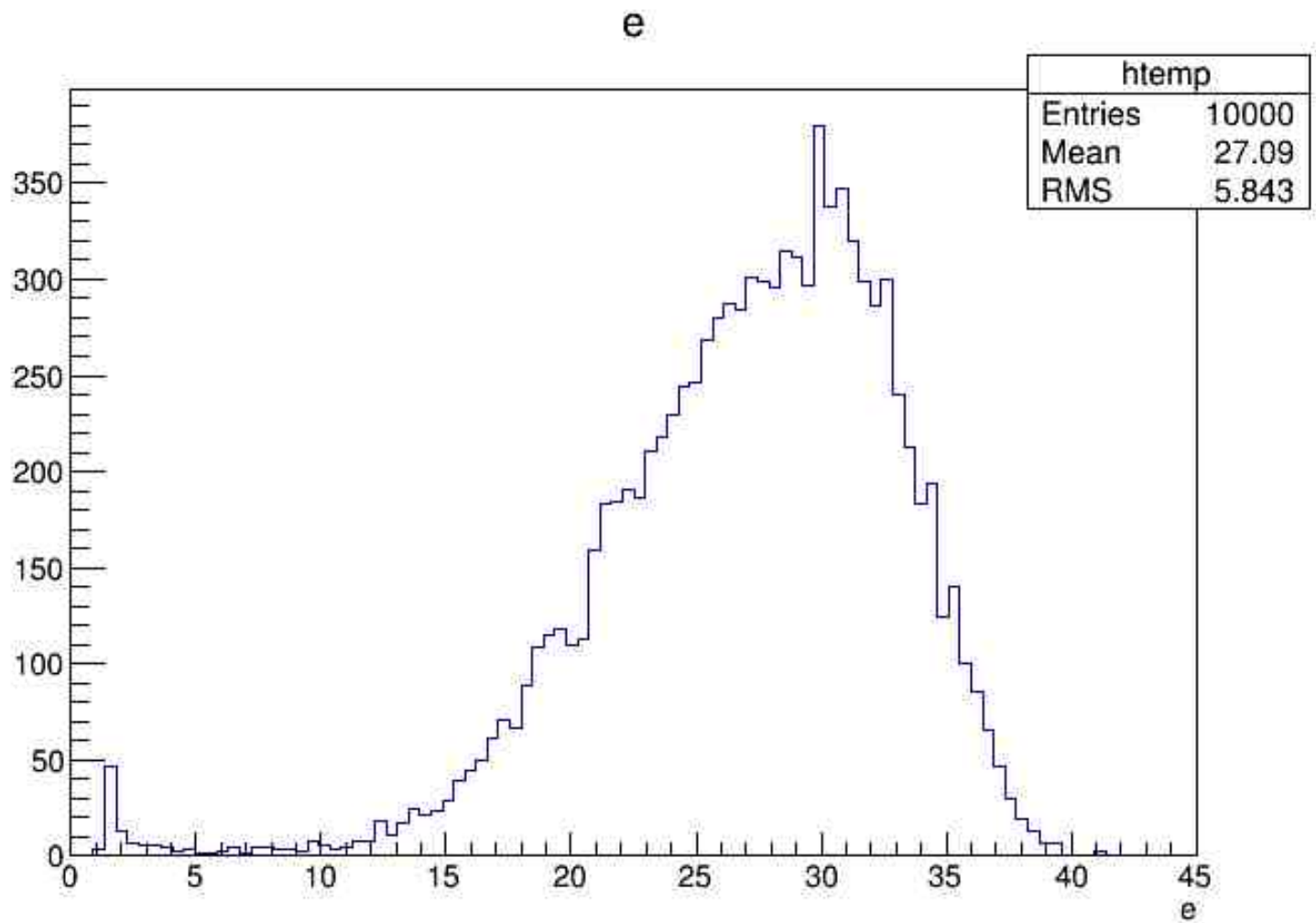
20 GeV


e
htemp
Entries 10000
Mean 13.32
RMS 3.258
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
e

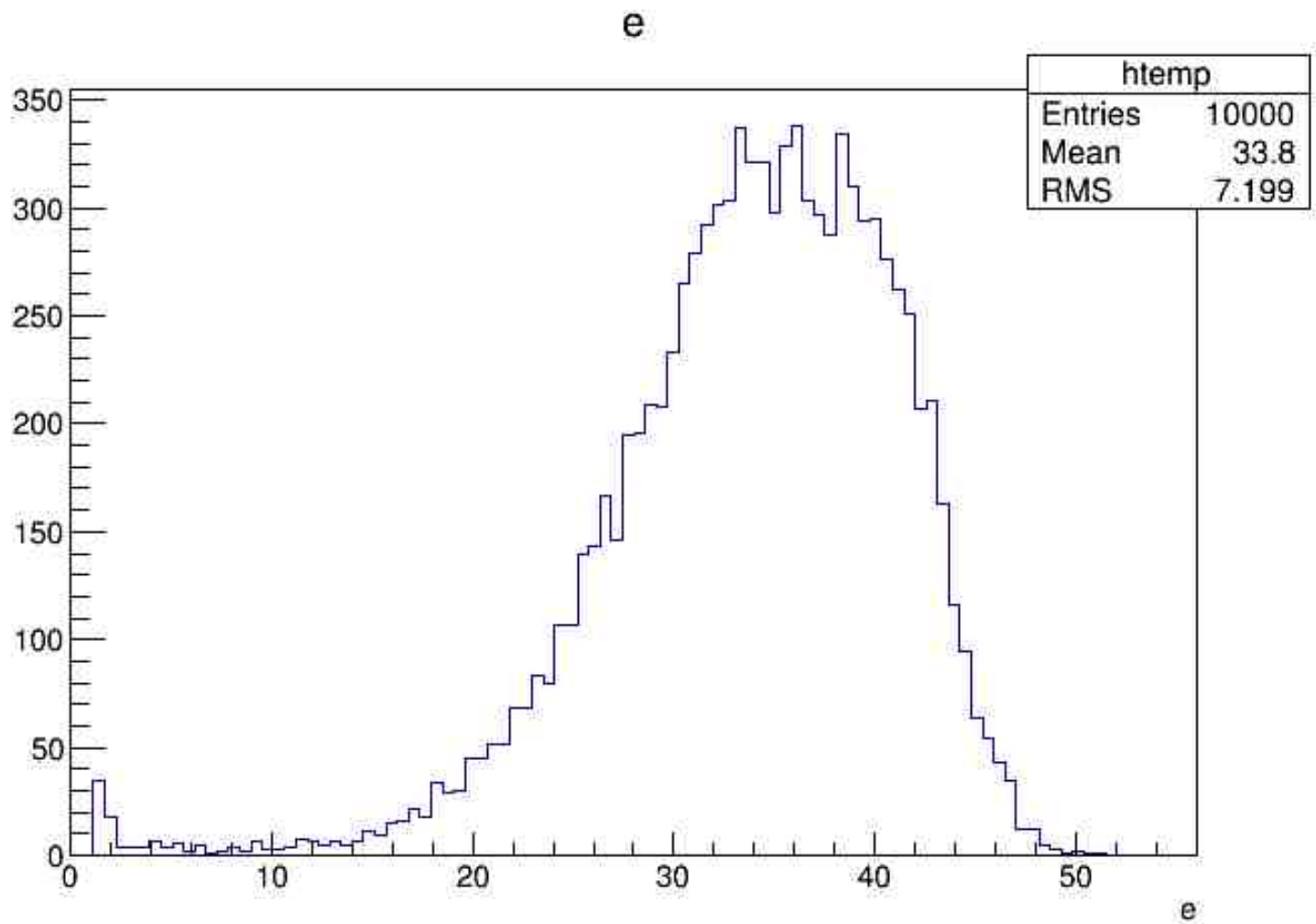
30 GeV


e
htemp
Entries 10000
Mean 20.19
RMS 4.553
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
e

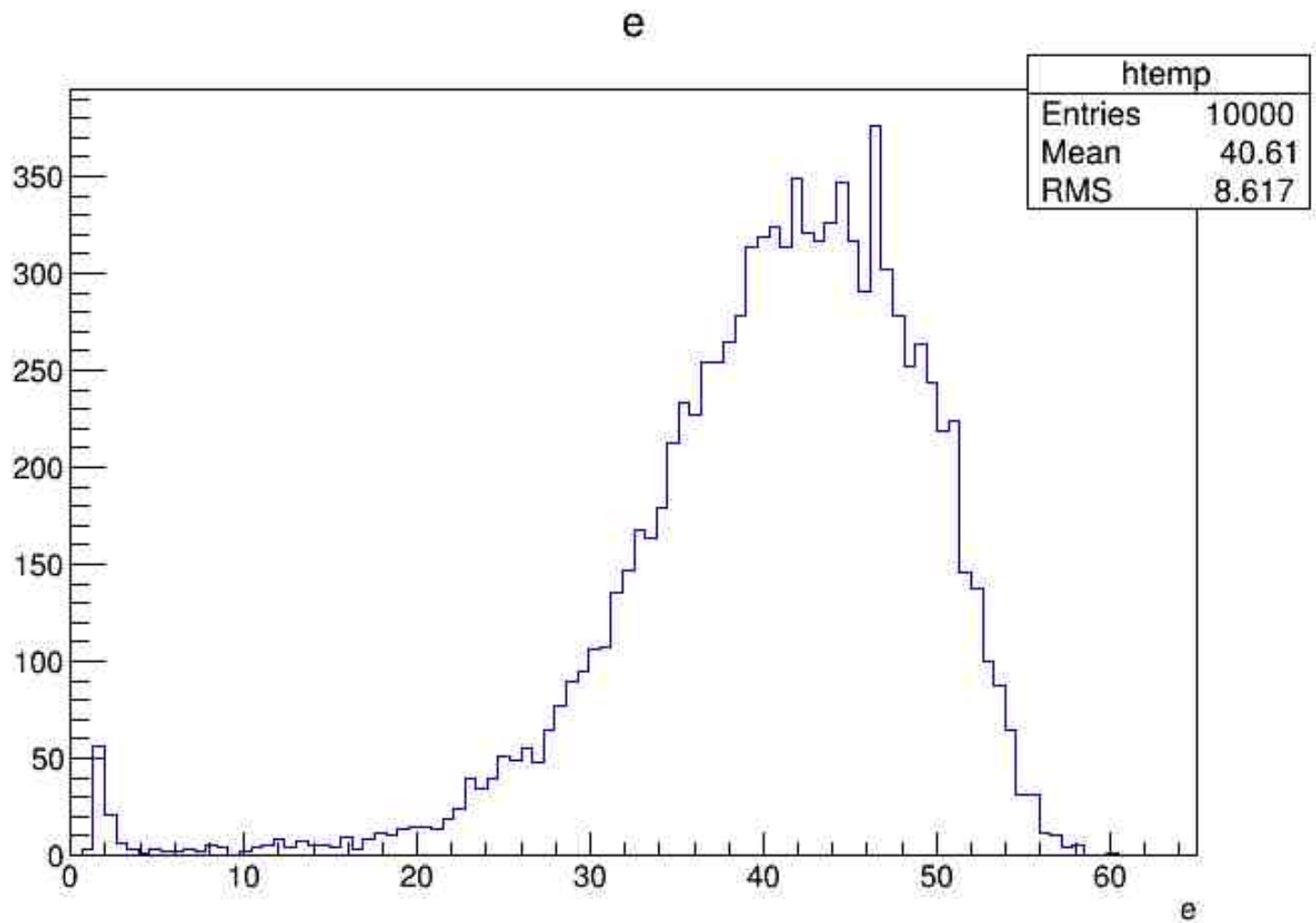
40 GeV


e
htemp
Entries 10000
Mean 27.09
RMS 5.843
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
40
45
e

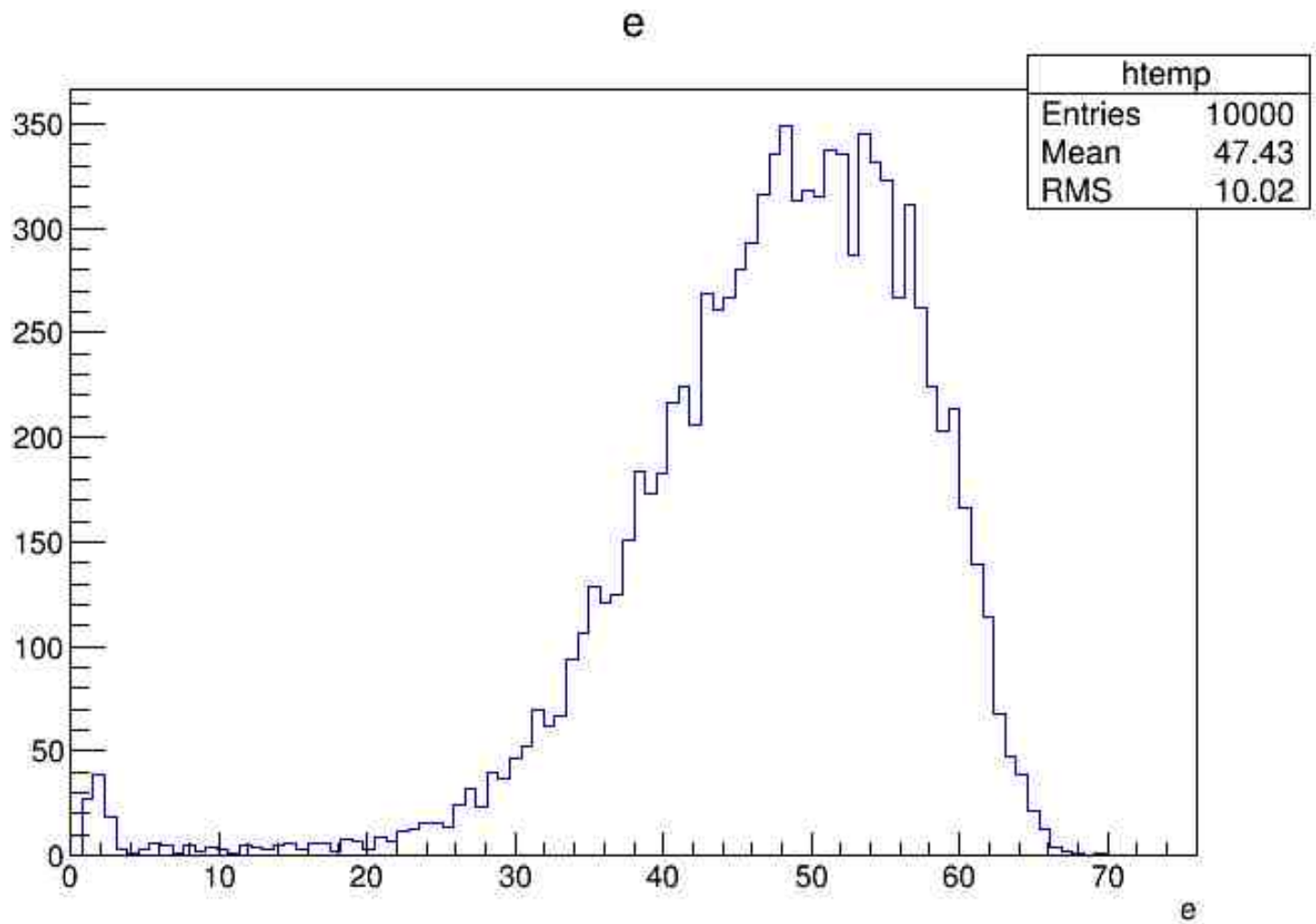
50 GeV


e
htemp
Entries 10000
Mean 33.8
RMS 7.199
350
300
250
200
150
100
50
0
0
10
20
30
40
50
e

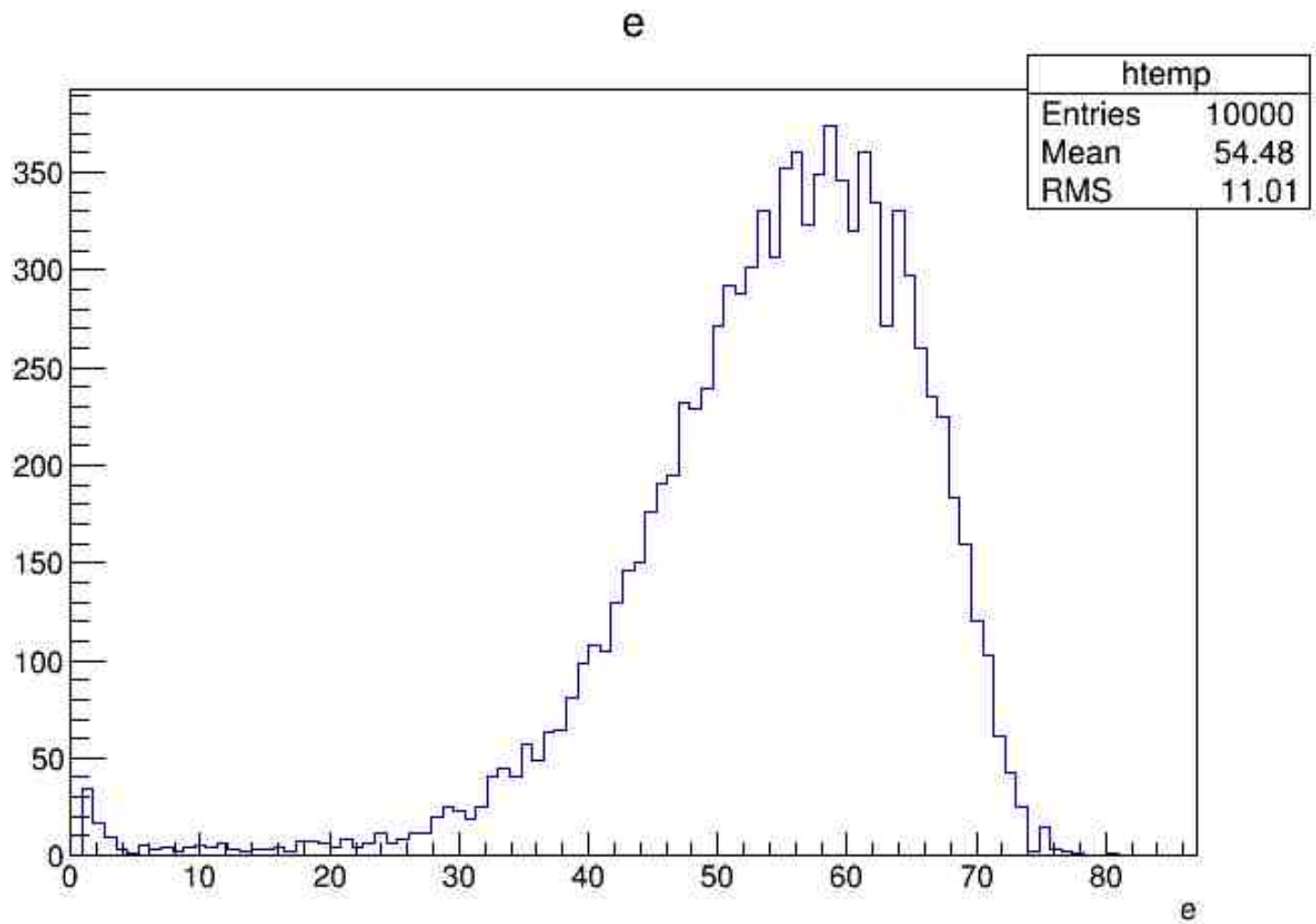
60 GeV


e
htemp
Entries 10000
Mean 40.61
RMS 8.617
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
e

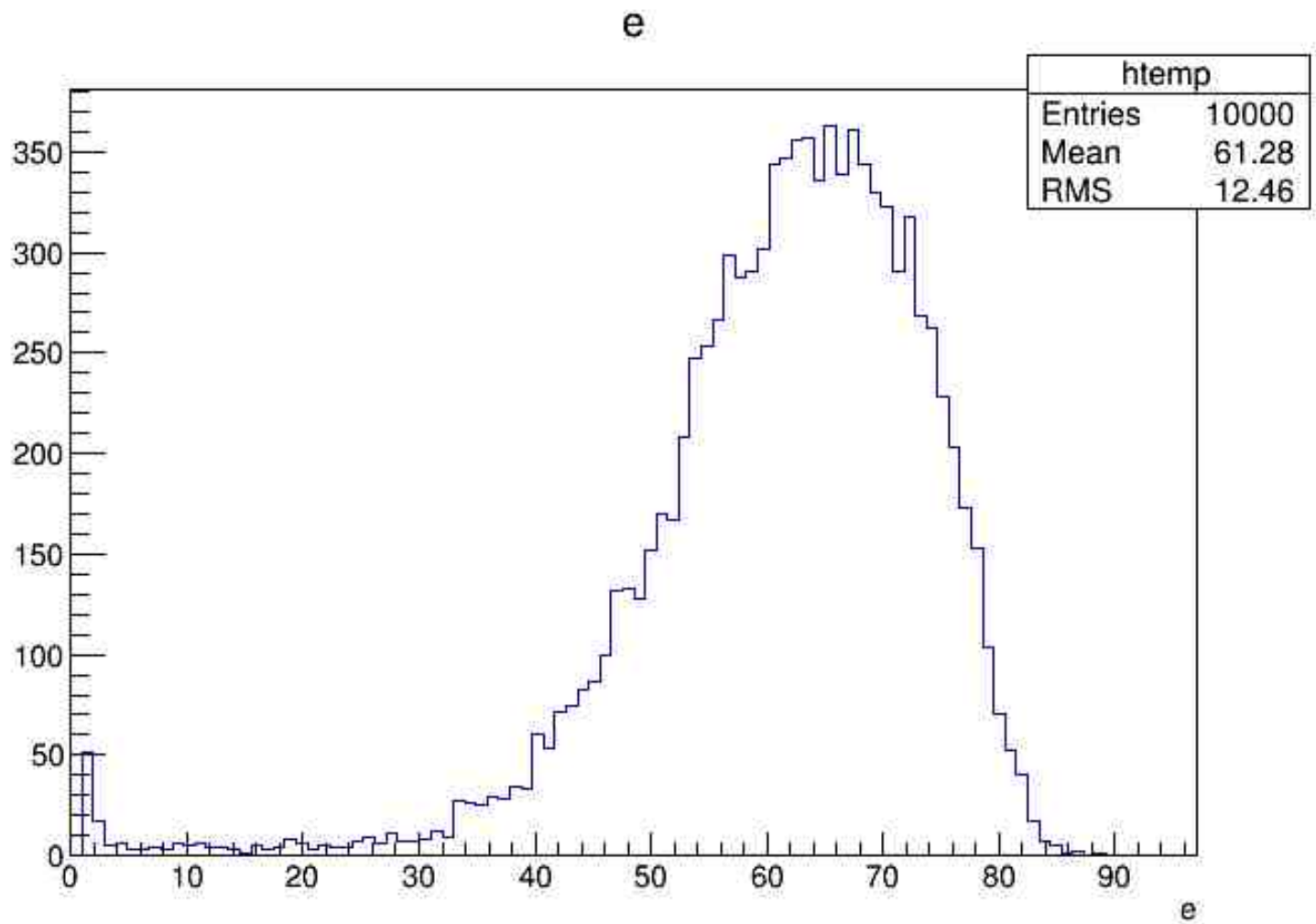
70 GeV


e
htemp
Entries 10000
Mean 47.43
RMS 10.02
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
e

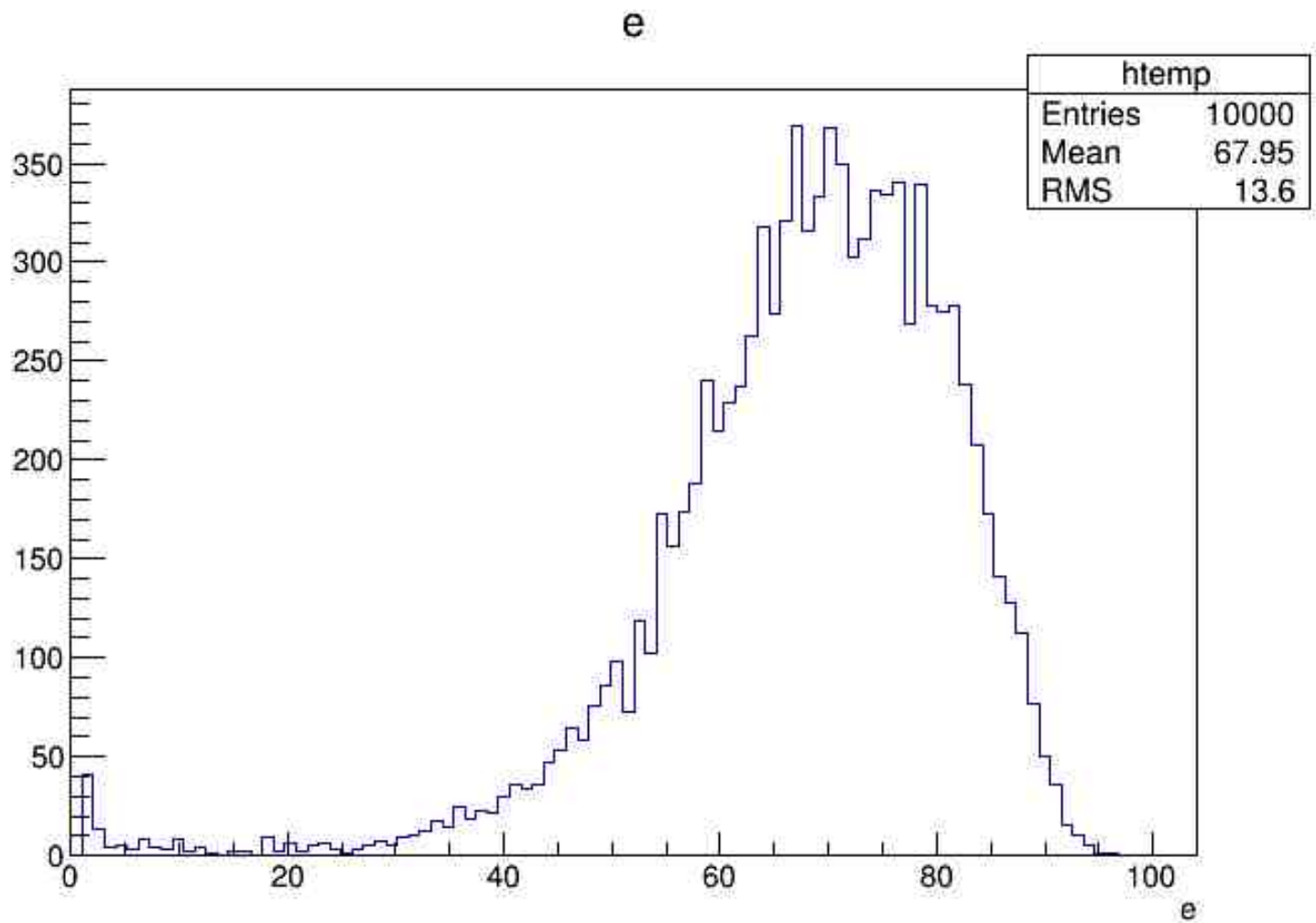
80 GeV


e
htemp
Entries 10000
Mean 54.48
RMS 11.01
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
e

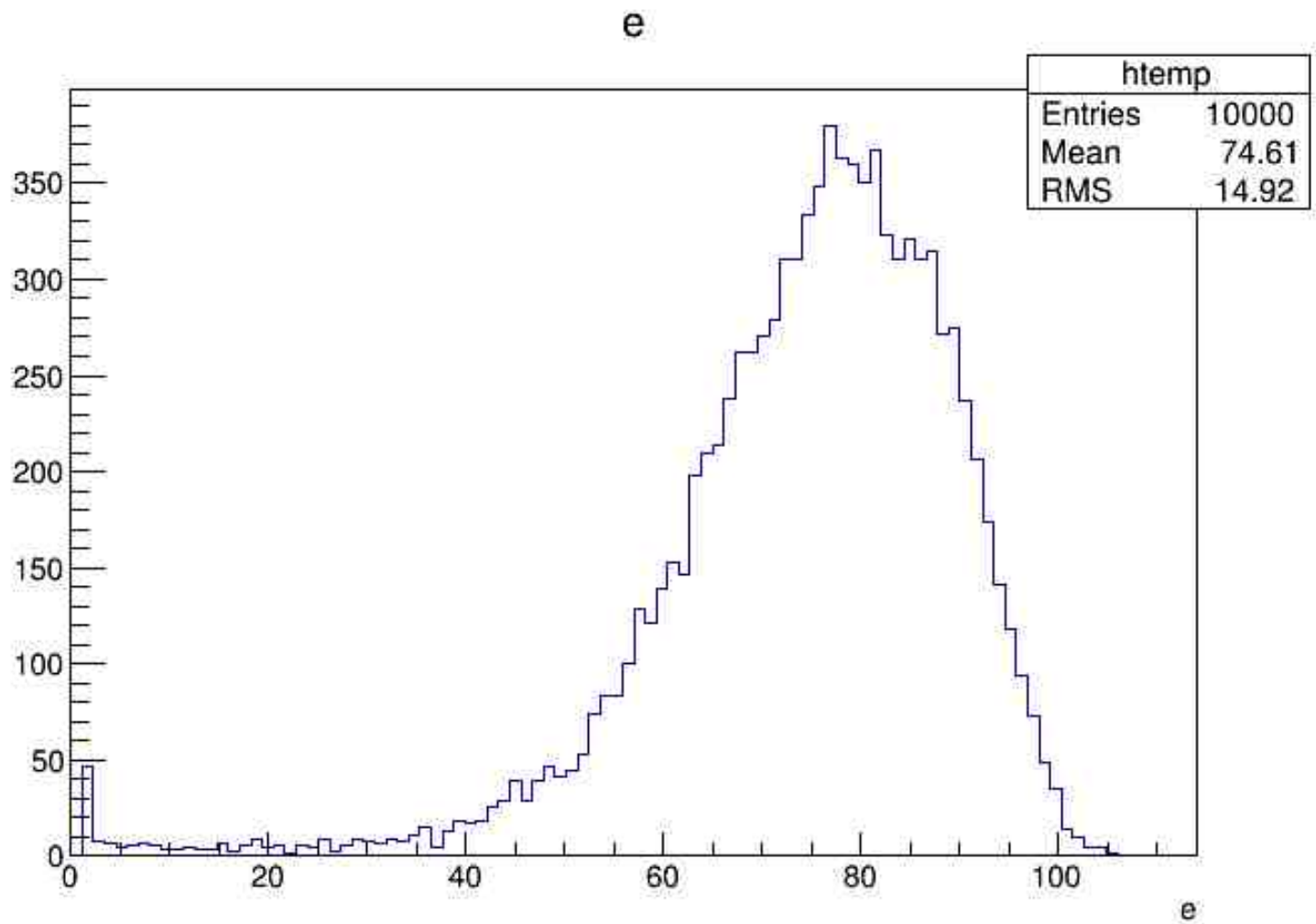
90 GeV


e
htemp
Entries 10000
Mean 61.28
RMS 12.46
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
e

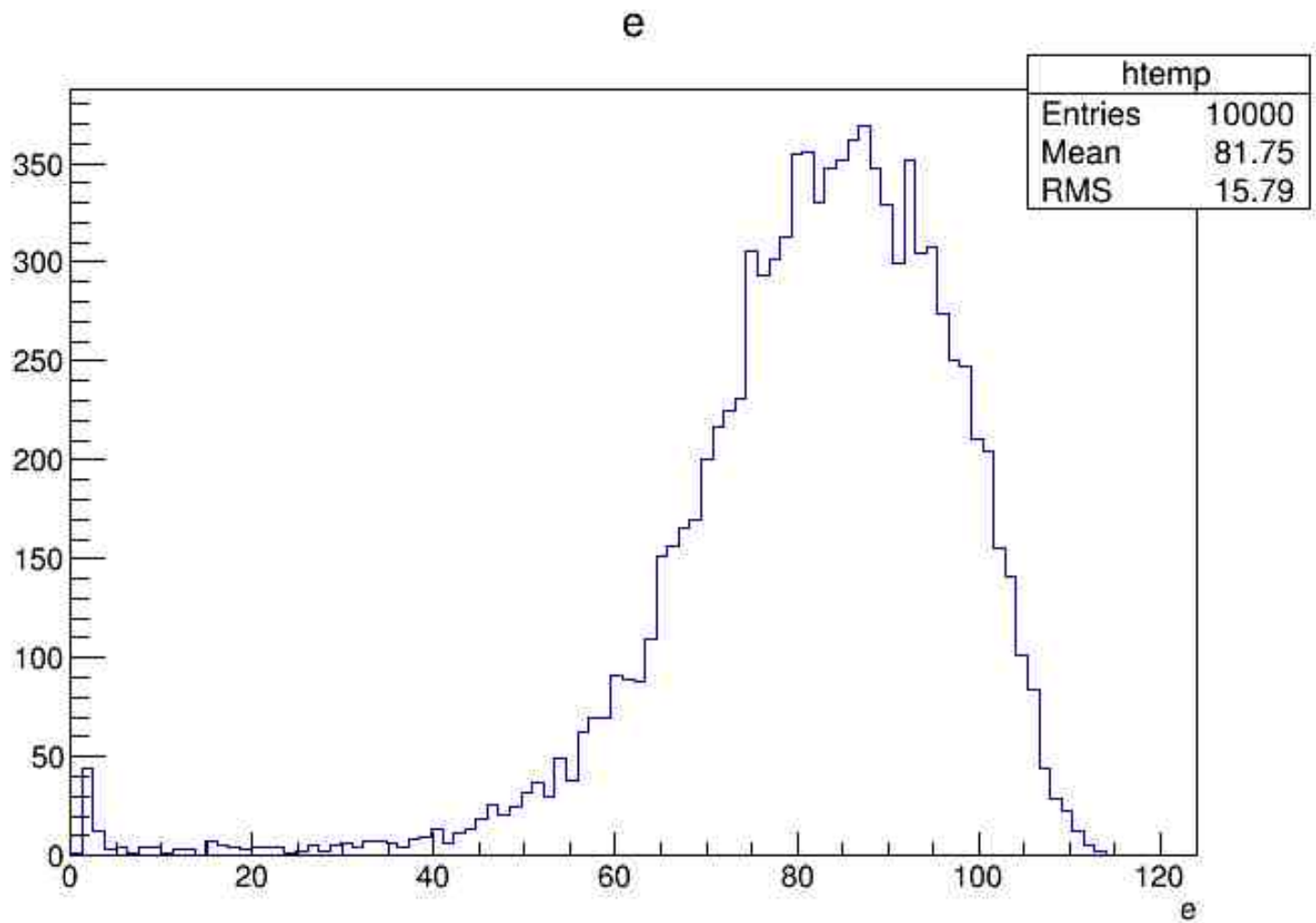
100 GeV


e
htemp
Entries 10000
Mean 67.95
RMS 13.6
350
300
250
200
150
100
50
0
0
20
40
60
80
100
e

110 GeV

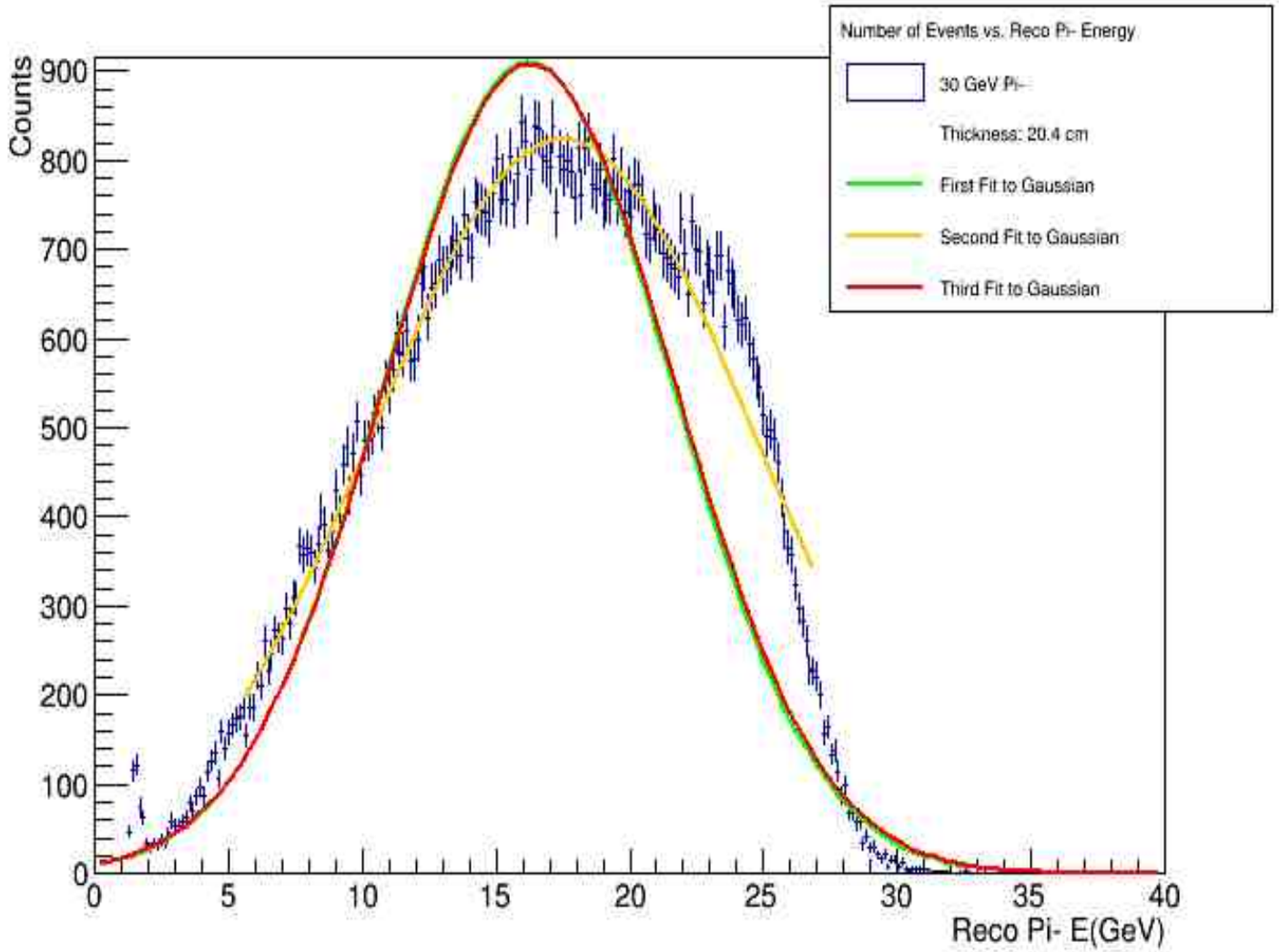

e
htemp
Entries 10000
Mean 74.61
RMS 14.92
350
300
250
200
150
100
50
0
0
20
40
60
80
100
e

120 GeV

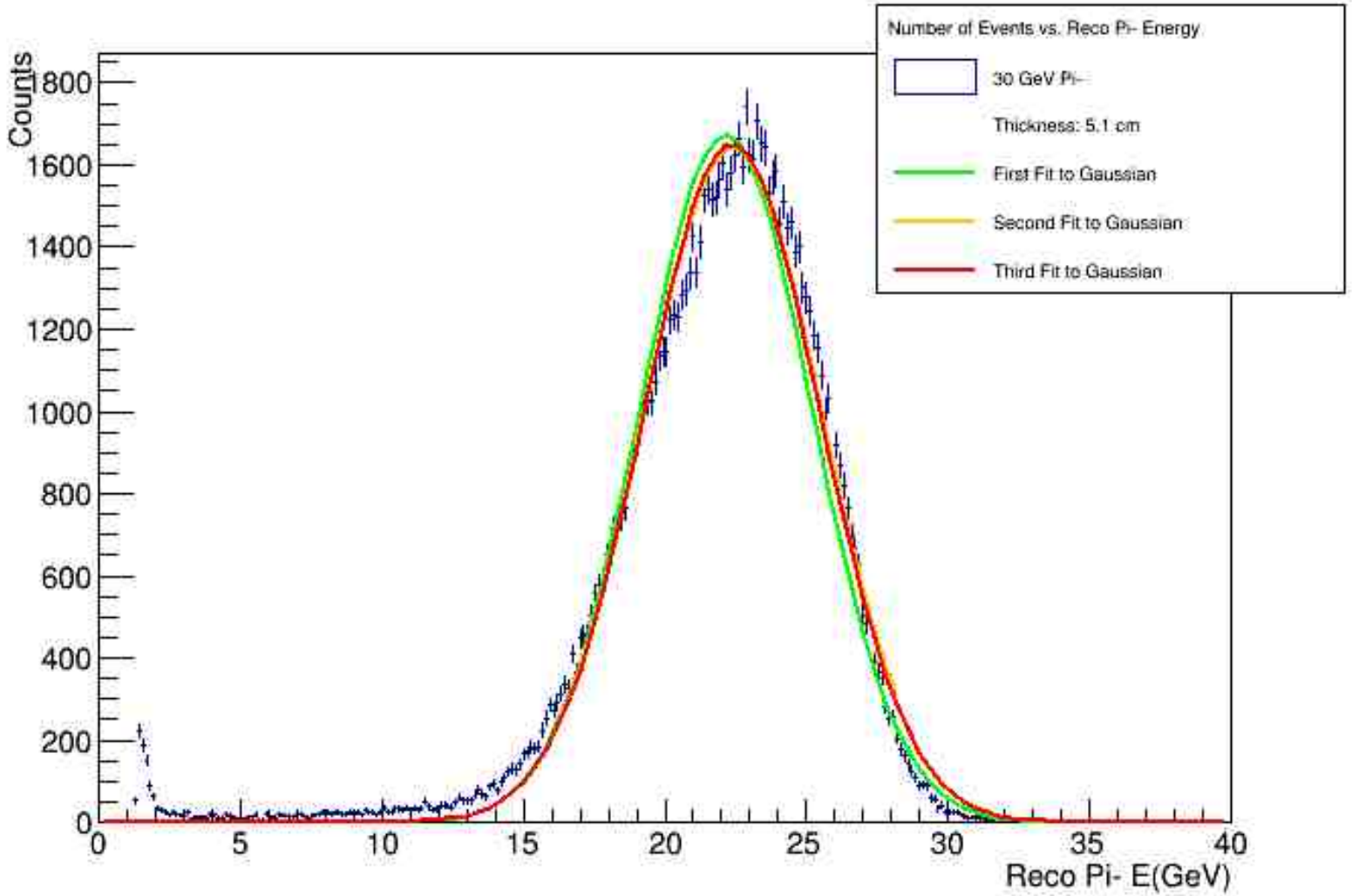

e
htemp
Entries 10000
Mean 81.75
RMS 15.79
350
300
250
200
150
100
50
0
0
20
40
60
80
100
120
e

Fitted Histograms

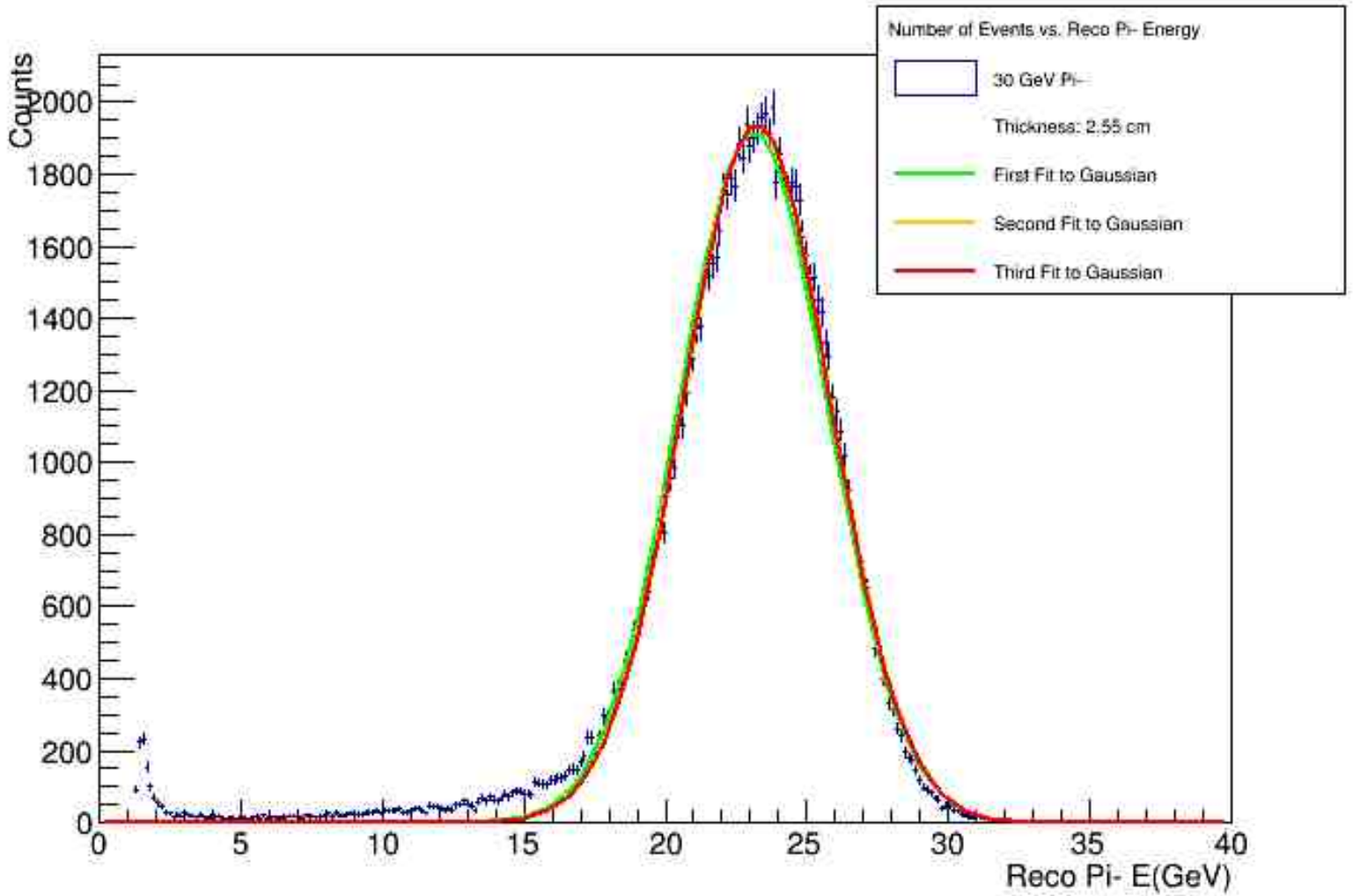
20.4 cm (Double) Plots



5.1 cm (Half) Plots



2.55 cm (Quarter) Plots



0.1 cm (Millimeter) Plots